DIFFERENCES IN FACIAL EXPRESSIONS, CARDIOVASCULAR ACTIVITY, AND SELF-REPORTED LEVELS OF EMOTION BETWEEN ANXIOUS AND NON-ANXIOUS PEOPLE

by

David W. Nordstokke

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ABSTRACT

Stress and anxiety can play a role in the development of cardiovascular disease. Differences in peoples' behavioral, cardiovascular, and self-reported emotional reactions to an interpersonally challenging task were measured. Two groups, highly anxious people (n = 17) and less anxious people (n=15) were defined by scores on the trait form of the Spielberger State-Trait Anxiety Inventory. They then underwent two interview conditions. One condition was a non-challenging control interview (CI) and the other condition was the socially challenging favorable impressions interview (FI) (Borkovec et al., 1974). Analyses attempted to describe difference between highly anxious and less anxious participants' facial expressions, cardiovascular activity and self-reported experience of emotion. Self-reported emotional responses differed between high and low anxiety groups. There were also cardiovascular differences between high and low anxiety participants in their reactions to stressful tasks. Findings show that highly anxious people tended to increase the intensity of their facial expressions during the stressful condition, whereas low anxious people did not change the intensity of their facial expressions between the interviews. These findings suggest that differences between high and low anxious people may provide useful information for identifying these individuals, which may be helpful in preventing later health problems.

Table of Contents

List of Tables

List of Figures

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CHAPTER ONE

Literature Review

Research in health psychology has increasingly supported the conclusion that behavior, emotions and other features of our psychological make-up can play unforeseen roles in modulating our bodies' reactions to environmental demands. For example, an abundant literature demonstrates that people who have high levels of social support, such as the presence of friends, confidants and other social connections, have lower mortality rates than those with more limited social support (Prkachin & Prkachin, 2002). People who report high levels of the emotion anxiety show increased evidence of heart disease relative to people who report lower levels (Rozanski, Blumenthal & Kaplan, 1999). There is even evidence that communicative behaviors can mediate physiological activity when people voluntarily adopt certain facial expressions (Ekman, Levenson & Friesen, 1982). This thesis addresses aspects of such observations. It is focused on the behavioral and physiological correlates of a pervasive human characteristic that is often considered a form of psychopathology: social anxiety. It has three fundamental goals. The first is to examine the degree to which the cardiovascular activity of people with high levels of social anxiety differs from that of people with lower levels in a situation designed to provoke social anxiety. The second is to examine the degree to which communicative behaviors indicative of negative emotion differentiates highly socially anxious people in the same circumstance. The third is to examine the degree to which the suspected physiological and behavioral correlates of social anxiety relate to each other. Answers to the questions posed in addressing these issues have the potential to enhance our understanding of the mechanisms of health effects of social anxiety and may shed light on risk of cardiovascular disease.

Social Anxiety

Even though people are generally social creatures, they are often uncomfortable in many social situations. Social anxiety can be generally defined as an unpleasant emotional state with qualities of dread, distress, and uneasiness in a social setting, typically accompanied by shyness and social awkwardness (Reber and Reber, 2001). The three-system analysis of anxiety proposed by Lang (1984, 1993) suggests that there are three main behavioral systems involved in anxiety responses. The components of an anxious response are found in (i) motor behavior; (ii) linguistic expressions; and (iii) psychological states. According to this theory the linguistic component of an anxious response encompasses the cognitive appraisal of the situation as well as verbal reporting. For example, using the above logic, when a person becomes anxious their reactions are manifested solely as deterministic response mechanisms. Even though psychological states are a component of this theory they appear to be portrayed as primarily reactive. It is possible that a person's initial response is physiological sending information to a receiver that the person is anxious and may evoke some form of negative response from the receiver. Heightened anxiety could be reinforced through learning; unfortunately their learning wouldn't be in a positive direction. This may be related to the negative appraisal of their experience.

Holt, Heimberg, Hope, and Leibowitz (1992), as cited in Leary and Kowalski (1995) suggest that there are several characteristic situations that evoke social anxiety. One such situation occurs when a person believes that he or she is being judged by others. The key component to social anxiety appears to be the real or imagined perception that one is being placed under someone else's scrutiny. For example, Baldwin and Main (2001) gave participants a series of computer-based multiple choice tasks that led them to believe that their responses were rated socially desirable or undesirable. At the end of these tasks the participants were asked to rate their level of comfort. Those who were rated as highly self-conscious reported lower comfort scores in both the control and the social rejection conditions; although they reported nearly the same level of comfort in the social acceptance condition suggesting that their cognitive appraisal of the situation was only affected by the negative aspect of the interactions. This suggests that those who are high in social anxiety seem to focus their negative attention toward a situation that has been appraised as 'negative'.

Sheffer, Penn, and Cassisi (2001) have also studied the effects of impression management on several physiological and self-report measures. Participants were evaluated in a high impression management condition compared to a low impression management condition. In the low impression management condition participants were told that the confederate, who was present in the room, was the focus of attention. Participants were told that the confederate was instructed to make the best possible impression and they were to evaluate their performance. In the high impression management condition participants were told that they were the focus of the evaluation and they were supposed to make the best possible impression to that person. Those in the high impression management condition reported significantly higher anxiety. This finding likely reflects the importance of self-directed cognitive factors in social anxiety.

Cognitive Factors Relating to Social Anxiety

There are several major cognitive aspects that play a role in social anxiety. These factors determine an individual's reaction to a social situation. A major component in the development of social anxiety relates to cognitive factors that influence one's perceptions and appraisals of a given social environment. This top-down processing approach generally called 'cognitive appraisal' includes information received through present perceptions and past or remembered perceptions.

One of the major contributors to the cognitive aspect of social anxiety is self-focused attention. Self-focused attention can include negative self-evaluations, feelings of tension and discomfort, and the tendency to withdraw around others (Schwarzer, 1986). Individuals may evaluate a social situation as stressful because of insecurities relating to self perceptions of their inability to meet others' expectations. In turn these perceptions may lead to a perceived loss of status or worth. It has been demonstrated that a high level of self-focused attention is related to the fear of negative evaluation and self-reported anxiety (Woody & Rodriques, 2000).

The socially anxious are often preoccupied with their internal sensations and the negative interpretation of these feelings and consequently they are usually less attentive to what is happening around them (Rachman, 1998). In a study conducted to assess the relationship between social anxiety and perceived external stress cues, Perowne and Mansell (2002) had high and low anxiety participants give a speech to a panel of confederate judges. The judges gave positive and negative non-verbal feedback to the performers during their speech. Less anxious participants accurately judged the differences in feedback from the panel, whereas the highly anxious participants were significantly less accurate and reported more self-focused attention. This suggests that those experiencing elevated levels of social anxiety are withdrawing from the social situation they are currently in and focusing on their own experience of the situation, perhaps distorting their perception leading to a misattribution of others' intentions.

Other cognitive aspects of social anxiety include memories of past events, hypervigilance, and learning. Negative information stored in memory serves to provide information about past social interactions and typically serves to guide an individual in their social environment. Information stored in long term memory serves as an origin for negative appraisal of future social events. As noted by Eysenck (1997), selective attentional bias to external stimuli is shown when threat-related stimuli are processed preferentially, or when threat-related stimuli can be located faster than neutral stimuli. In similar fashion, selective attentional bias to negative information stored in long-term memory is shown when the information is more readily accessed than neutral information stored in long-term memory. This suggests that those suffering from chronic social anxiety may be caught in a thought processing feedback loop where memories, or perhaps distorted recollections, of past events determine their approach to (or more likely avoidance of) interpersonal interaction. It is evident that memories must be coupled with a hyper-vigilant disposition to result in the experience of anxiety. Hypervigilance is considered a vulnerability factor for anxiety disorders and in non-patient groups that are high in trait anxiety. As stated by Rachman (1998), many patients suffering from anxiety disorders experience hypervigilance and selective attention for memories on a daily basis. This list of symptoms sets the stage for an individual to receive reinforcement for their distorted perceptions or memories, leading to avoidant behavior or increased anxiety as a result. These individuals alter their behavior according to their learned belief system which, in turn, affects their ability to communicate and interact effectively (Edelmann, 1992). The key element is the distorted cognitive processing. This distorted processing leads to a change in behavior, which in turn results in awkward social communication styles by the socially anxious.

Interpersonal Communication and Anxiety

Interpersonal communication occurs when we are engaged in an interactive dyad with another individual (Beebe, Beebe, Redmond & Milstone, 1997). Channels of interpersonal communication are used to convey information between senders and receivers. Smith and Williamson (1985) reviewed several message systems (channels) used for a communicative dyad. They suggest that in humans, language is the primary message system since it is the most widely used form of communication. Their review also includes gestures and non-verbal behavior, including facial expressions, as another important channel of communication. A third type used is personal space. This suggests that there are differences in the distance in the space people choose to place between themselves and others and this in turn affects their communication. Communication channels are important for people to accurately detect and decode messages from others. Interference or 'noise' has an effect on the channels by degrading the signal between the sender and the receiver (Beebe, Beebe, Redmond & Milstone, 1997). If a person behaves awkwardly in a given social interaction, then the 'noise' created by the odd behavior could degrade the signal and the receiver may not properly understand the information or the person's intentions.

Another distortion of communication may result from the fact that individuals who have high levels of social anxiety tend to rely on simplistic information processing (e.g., stereotypes) leading to ineffective communication (Gudykunst & Nishida, 2001). This can lead to further problems in the sending and receiving of information between two communicators. As stated by Edelmann (1992), those who are highly anxious in a social environment may change their communication style to fit their stereotypic beliefs and evaluations. This also adds noise to channels potentially leading to an uncomfortable interaction and miscommunication. The information being sent between two individuals can be susceptible to noise, interfering with the signal being sent as well as influencing the decoding process. For example, a socially anxious individual may alter their signal producing behavior, and thereby degrade the information, which adds noise to the signal. Also, a socially anxious individual may receive a signal, but may decode it in an imprecise manner due to cognitive distortions about the situation, thereby interfering with the correct deciphering of the information carried by the signal.

Although verbal communication is a major channel of interpersonal interactions non-verbal communication channels play a prominent role in an information exchange between two individuals. Cappella (1985), as cited by Segrin (2001), states that it is evident that social anxiety interferes with non-verbal communication skills. Being unable to modulate one's behavior reflects diminished non-verbal social capabilities in the socially anxious. During a stressful situation the highly anxious person is likely to display awkward behaviors.

Relationship between anxiety and cardiovascular disease

Anxiety is among the psychosocial risk factors believed to be involved in the development of hypertension, coronary heart disease and other types of cardiovascular disease (CVD) (Turner, 1994; Manuck, Kaplan, & Clarkson, 1983; Merz, Dwyer, Nordstrom, Walton, Salerno & Schneider, 2002; Rozanski, Blumenthal & Kaplan, 1999). If anxiety is, in fact, a risk factor for CVD, an important question concerns the mechanism through which it exerts its influence. Investigators addressing this question typically begin with the observation that the behavioral state of anxiety is known to be physiologically provocative. During stress an individual goes through many physiological changes that are related to how he or she perceives environmental conditions. Incoming perceptual signals are integrated into many neural networks, which influence autonomic, hormonal, and physiological responses (Pinel, 2000). The physiological changes induced by stressful events have come to be termed "stress reactivity". Stress reactivity affects such basic cardiovascular functions as heart rate by increasing the absolute speed at which the heart beats and decreasing the heart rate deceleration effects of the parasympathetic nervous system (PNS), producing a condition of sympathetic nervous system (SNS) dominance. SNS dominance is a strong predictor of heart failure (Sharpley, 2002).

Those who experience high levels of anxiety are likely to experience high levels of arousal. Moreover, as reported by Prkachin, Mills, Zwall and Husted (2001), socially stressful events may produce larger, more sustained blood pressure reactivity than those produced by non-social stressors. An individual prone to experiencing a high level of social anxiety would thus likely experience even more reactivity to social stressors. If such an individual is in a situation where their anxiety reaches high levels, then the SNS will likely dominate, increasing heart rate and blood pressure. Repeated episodes of this nature could provoke patho-physiologic changes by exposing the cardiovascular system to repeated rapid fluctuations in rhythm and beat frequency perhaps resulting in long-term damage. Indeed, there is evidence that anxiety elicited in social situations is linked to several cardiovascular illnesses such as atherosclerosis and lethal arrhythmias (Merz, Dwyer, Nordstrom, Walton, Salerno & Schneider, 2002).

Behavioral Markers

If it is, in fact, the case that reactivity associated with social anxiety does enhance health risk, then it would be important to be able to identify individuals prone to such effects. Are there signs or markers that could provide evidence of the patho-physiologic processes? Establishing the behavioral characteristics of anxiety experience could lead to the identification of behaviors that identify risk and, consequently, may lead to the prevention of cardiovascular illnesses.

In a study relating facial expressiveness to blood pressure, participants underwent the favorable impressions (FI) interview (Davidson, Prkachin, Mills and Lefcourt, 1994). The FI interview is an interpersonally challenging task that elicits social anxiety from the participant by placing them in front of an opposite sex confederate to the study. Participants are given a set period of time to create a positive impression of themselves to the confederate. The anxiety-provoking potential of the test is intensified by ensuring that the confederate does not respond in any way, verbally or nonverbally, to the participant (Borkovec, Stone, O'Brien & Kaloupek, 1974). Davidson et al. (1994) found that facial expressions measured during the test did predict higher systolic blood pressure

(SBP). In the coding of facial expression all twitches or movements that were not considered emotional were not coded. Coding the face in this manner may have neglected spontaneous facial movement, which may be related to psychological stress or physiological events that are occurring in that individual. Alternative methods for measuring facial behavior, such as the Facial Action Coding System (FACS; Ekman & Friesen, 1978) are likely to provide more precise information than the coding system used by Davidson and colleagues regarding the nature of facial expressive changes occurring during such tasks. By using FACS the coder is able to quantify all facial movements including movement intensities and asymmetries. The FACS procedure may lead to the identification of specific facial expressions denoting an individual experiencing stress and possessing a high degree of heart rate reactivity.

One of the most widely accepted facial markers of emotional experiences was described by Duchenne and is known as the 'Duchenne smile' (Duchenne, 1862/1990). Evidence suggests that this facial configuration represents the difference between a social smile and a spontaneous smile, and thus that the Duchenne marker represents the actual feeling of enjoyment. The Duchenne smile is indicated by the action of orbicularis oculi, pars lateralis in conjunction with zygomatic major activity (Frank, Ekman, & Friesen, 1993). Zygomatic major controls the upward movement of the mouth and is involved in both Duchenne and non-Duchenne smiles, whereas orbicularis oculi and pars lateralis activity around the eyes and upper face narrows the eye aperture and produces other changes in appearance, which are involved only in the Duchenne smiles. It is the difference between the facial action during the Duchenne and non-Duchenne smile that acts as a marker for enjoyment. In a study by Ekman and his colleagues (1990) participants showing Duchenne smiles reported feeling more enjoyment than those showing non-Duchenne smiles.

Other researchers have suggested that facial expressions mark differences between hostile and non-hostile individuals (Prkachin and Silverman, 2002; Chesney et al., 1990). Since hostility is another psychosocial factor implicated in the development of CVD, this body of evidence suggests that those individuals showing a high frequency of hostile facial patterns may have an increased risk for developing CVD. Establishing connections between facial patterns and subjective appraisals of experience or physiological reactions could provide health care practitioners with information that may lead to the identification of high-risk individuals.

Facial Expressions and Anxiety

Emotional expression can be defined as any anatomical, muscular, physiological, or behavioral reactions that accompany a felt emotion and functions as the manner in which it is displayed (Reber and Reber, 2001). Buck (1984) discusses a proposed theory of the expression of emotions that was formulated from the work of Paul Ekman and colleagues. It basically states that ultimate facial expression is a joint function of the spontaneous, innate, and universal mechanism, and the symbolic, learned, and culturally variable mechanism. Spontaneous expression is classified as reflexive or automatic and symbolic expression is classified as voluntary with the sender intending to convey a specific message. Symbolic expression is also referred to as social expression (Buck, 1984), which is voluntarily generated with a specific social outcome in mind but may not always be honest. Spontaneous expressions may hold honest information regarding the experience of the signaler because, in theory, they reflect the internal processing of the individual at functional levels that are difficult to modulate.

It was suggested by Fernandez-Dols (1997) that social context, emotion, and facial actions constitute a tension system that involves bidirectional relationships. Facial actions index the causal interrelationships between emotional and contextual factors. This means that emotion does not induce facial action, but it may facilitate whatever facial action is induced by a particular social context (Fernandez-Dols et al., 1997; Ruis-Belda et al., 2003). Specific spontaneous facial expressions may be an indicator of physiological reactivity. That is, when an individual displays a spontaneous facial expression this may indicate that there is a high probability that they are experiencing a distinct, possibly elevated, physiological response. Some researchers have reported that there is no relationship between voluntary facial movement and heart-rate by having participants pose expressions of emotions (Boiten, 1996). This is somewhat contrary to the findings of Ekman, Levenson & Friesen (1983) who showed that voluntarily producing facial expressions of emotion generated emotion-specific autonomic changes. In neither study did the researchers count the spontaneous facial expressions during the task; they only measured physiological activity during the posed expressions. These studies neglect to take into account spontaneous facial expressions, which may be more strongly linked to our psychological and physiological processes than posed or social expressions. Taking this into consideration, it may be nearly impossible to delineate the difference between spontaneous expression and voluntary expression. Although, Kappas and colleagues (2000) demonstrated that during a humorous event research participants who were told to inhibit their facial expressions "leaked" facial expressions indicating that they were amused. Relating this to social anxiety, a person may not likely want others to know about their levels of stress, and thus will inhibit and monitor all outward markers of their current state in order to hide it from others. While internally they may be quite reactive, they may appear relaxed, but through the calm outward appearance traces of their anxiety will leak through.

Spontaneous versus Posed Expression

A problem in studying facial expressions and their relationships to 'felt' emotion comes from determining whether or not a particular expression is spontaneous or posed. Spontaneous expressions appear quickly although they may be modulated by choice or habit (Ekman, Hager & Friesen., 1981). Dissociating spontaneous and posed expressions is a key component in the understanding of true emotional expression. Ekman et al. (1981) criticized much of the work that had been conducted on facial expression and emotion up to that point because many of the studies were not actually measuring emotional expressions; rather, they measured, posed facial expressions. To address some of these issues, Ekman et al. (1981) performed two studies. The first involved analyzing imitated and supposedly spontaneous expressions of emotion in children. In the first condition the children were asked to imitate the six basic facial expressions of emotion: happiness, sadness, fear, surprise, anger, and disgust. The spontaneous facial expressions were collected through the interviewer casually interacting with the participants in an attempt to elicit naturally occurring expressions. Unfortunately this method resulted in the collection of only happy facial expressions, which were then compared to the expressions in the first condition. The results showed that there was significantly more asymmetry in deliberate facial actions, at least for the expression of happiness. The second study involved videotaping adults while they viewed a pleasant film and a negative stress inducing film. The happy film elicited very few asymmetrical spontaneous expressions and those that occurred were split equally between the left and right sides of the face. In the negative condition there was a higher frequency of asymmetric facial expressions, and again there was no dominant side for facial asymmetry. These results are interesting because they demonstrate that different conditions elicit different facial actions.

Several issues arise from the reported research. The first is that the elicitation methods used may not have been accurately generating the appropriate emotion. For example, in the second study watching a stress inducing film may not have caused the generation of the emotional reaction it was intended to because facial expressions usually occur within a dyadic social interaction. Thus, one could argue that other methods used for studying facial expressions are artificial. A second problem with the results of the first study is its restriction to one expression, happiness. It has been suggested that positive expressions may be expressed more through the activity of left hemisphere of the brain and negative expressions through more right hemisphere involvement (Davidson, 1995).

One could argue that positive emotions are typically more social in nature and that humans evolved left hemisphere dominance for expressing positive emotion because it is usually more typical of human communication. Normally, communication takes place through language, which has strong left hemisphere dominance, so naturally one might assume that positive expression would be dominant in the left hemisphere since it is more closely located to language centers. Negative emotions could develop more dominance in the right hemisphere because the reactions of fear, stress, and threat are more related to survival responses. There is no need for a great deal of language required while experiencing these emotions because generally when these emotions are experienced immediate action is required, and bypassing language centers would create a more efficient response pathway. This suggests that during a positive emotional experience a person is likely to be in a social setting where it would be favorable for that individual to communicate with others. On the other hand, when one is experiencing a negative emotional experience survival strategies and action are usually required and there would probably be little communication, besides an alarm call. Support for this theoretical position would require evidence of an explicit connection between positive expressions and negative expressions and their eliciting conditions. Measuring of spontaneous displays of these expressions needs to be performed. This approach should be incorporated in future face analysis research.

Fernandez-Dols, Sanchez, Carrera, and Belda (1997) attempted to determine if spontaneous facial expressions and emotions are linked. In their review of the pertinent literature the authors reasoned that there was little to no agreement regarding the relationship between facial expression, emotion, and social displays. The researchers argued that most of the laboratory tests of the relationship between emotion and facial expression had only consisted of showing films to people and measuring their facial behavior, either by recording the facial expressions or by facial electromyography.

A total of 48 volunteers viewed a section of the movie *The Shining*. The clip was intended to produce an intense negative emotional reaction. The clip was preceded by another supposedly neutral clip from the movie *The Black Stallion.* Participants were shown the film clips and were unknowingly videotaped via concealed cameras. After the movie presentation had ended participants were asked to rate their emotional reaction to the clip on several measures including fear, anger, happiness, sadness, disgust, and surprise. Facial expressions were scored using the FACS.

Results showed very little coherence between facial displays and reported emotion. Many of the facial expressions displayed, such as disgust, were not accompanied by the subjective report of disgust. The authors discuss several reasons for the results. The most obvious reason for the lack of coherence could possibly have to do with induction method. Having a participant recall what their emotional state was during a video presentation is problematic because there may be modulation of the experience during the time period between the presentation of the stimulus and the self-report of the emotion. The authors have also suggested that their elicitor was not effective for creating the proper emotional response in the participants. This is the heart of the problem in this and similar studies. Presenting video excerpts to participants creates an artificial representation of facial behavior in the participant because it lacks the natural dyad of social interaction in which most facial behavior probably evolved. It is not surprising that the researchers did not find coherence between facial behavior and subjective emotional reports. The artificial nature of the study did not accurately tap into the reality of how facial expressions are displayed during social interaction. It is clear that future studies should try to create a more realistic social setting to elicit spontaneous expressions and emotional experiences. This would result in more ecological validity.

Levenson and Ekman (2002), reviewed studies that used the Directed Facial Action task to study physiological changes associated with components of emotion. This task requires participants to deliberately move facial muscles to produce expressions of emotion. The researchers believe that cardiovascular changes in emotion are part of an organized multi-system response in which the appropriate physiological support is provided for prototypical behavioral responses associated with certain emotions.
Ekman and Levenson reported that the facial configurations associated with anger, fear, and sadness produced the greatest increases in heart rate. Disgust was associated with the smallest increase in heart rate with happiness and surprise falling somewhere in between. The authors posited several reasons for this result, including the idea that the negative expressions are usually related to negative environmental situations where an individual would need to react quickly; hence the rapid increase in heart rate. Another possibility is that heart rate increases because of the difficulty in producing many of these expressions. However, there were some clear and consistent findings. First, there were autonomic differences that were most pronounced when configurations most closely resembled the associated emotional expression. Second, there were autonomic differences that were most pronounced when subjects reported experiencing an emotion, and third, subjects reported experiencing the associated emotion most strongly when configurations most closely resemble the associated emotional expression.

Carroll Izard (1994) suggests that there is a biologically driven need for behavioral displays of emotional experience. He argues that this connectivity between innate emotion experience and its displays can become modified through experience. Experience can modify the relation such that there is dissociation between emotional experience and display characteristics. In other words one can learn to modulate and even mask emotional displays in an effort to interact in a social environment.

The universality hypothesis, which relates to the differential emotions hypothesis, states that emotions (including neural, expressive, and experiential components) are inherently adaptive and that each discrete emotion has unique organizational and motivational properties. Since they are inherently adaptive they will occur in all populations of humans.

According to Izard, the innate-universality hypothesis (IUH) consists of two distinct components: innateness and universality. It is conceivable that a facial expression could be innate yet not expressed in a culture due to display rules. On the other hand, a facial expression may be universal but not innate due to simultaneous learning processes and experiences in all cultures. The argument of the IUH, according to Izard, is that evidence on the ontogeny of facial expressions in early development supports the notion that certain facial expressions are innate and that their innateness links them to the human evolutionary-biological heritage.

Several of Izard's concepts are important in the context of the present study. First, the relation of facial expressions to discrete emotion states should be recognized as a different issue from that of relating expression to affective-cognitive structures. Second, the ecological validity of facial expressions is a complex issue that will require a functional approach to the study of activator-expression-behavior relations. These key concepts are related to the dissociation between social expressions and spontaneous expressions, which may be related to the modulation of certain innate expressions and the communication of one's internal state. In other words, there may be innate expressions that are modified after birth, and a set of innate expressions that, even though modification takes place, reliably indicate the internal emotional experience of an individual. Through this link researchers may be able to begin to identify and recognize specific facial actions that could act as a marker for the experience of stress in people.

Relationship between asymmetric facial expressions and anxiety

Hemispheric asymmetry has been shown to occur in brain processes related to language and music (Kolb and Whishaw, 1998). It has been posited that structural and functional brain asymmetry may result in more efficient utilization of brain functioning. It should be stated that brain asymmetry does not mean unilateral brain processing where one hemisphere houses all the processing for a given function. Brain asymmetry simply means that one hemisphere of the brain is responsible for a larger proportion of processes for a given function. Davidson (1995) suggests that there is hemispheric specialization for approach and withdrawal processes. He suggests that the left hemisphere is related to approach/positive experience and the right hemisphere is related to withdrawal/negative experience. It follows that structural and functional asymmetries in the brain should naturally be expressed in an organism's behavior protocols.

It has been suggested by several researchers that asymmetric facial behaviors are related to the experience of stress or anxiety (Shackleford & Larsen, 1997; Schiff & MacDonald, 1990; Nakamura, 2002). Elevated arousal in highly anxious individuals may manifest itself in the facial expressions generated by those people. It has been demonstrated that there are more asymmetries present in spontaneous than in posed mouth movement (Wylie & Goodale, 1988). An individual placed into an awkward social situation may become so highly aroused that they effectively 'short circuit' and the result is exaggerated facial asymmetry. Fernandez-Carriba, Loeches, Morcillo, and Hopkins (2002) found that during fear and threat behaviors, which could be argued, are quite arousing, facial mouth movements were more asymmetric. This suggests that those who are experiencing elevated levels of stress may display altered facial behavior, effectively marking their reactivity to stressful situations.

Overview of the present study

The foregoing literature review identifies a number of themes which suggest links among emotional response predispositions, particular kinds of psychological stress, parameters of emotional communication and parameters of physiological activity that have been implicated in the development of cardiovascular disease. To summarize the key points in a slightly different order than articulated above:

1. There is evidence that psychological stress induces changes in cardiovascular activity.

2. There is evidence that stress-induced changes in cardiovascular activity may play a role in cardiovascular disease pathogenesis.

3. There is evidence that social stress induces differentially large changes in cardiovascular activity.

4. There is reason to believe that such differential cardiovascular effects may be exacerbated in individuals predisposed to experiencing high levels of social anxiety.

5. There is reason to believe that predisposed individuals may display different patterns of emotional expression that mark their risk. One element of this differential pattern may be the existence of asymmetries in facial expressions.

Although several of these issues have been addressed in available research, they have yet to be examined comprehensively. The purpose of the present study were to examine psychophysiological and behavioral differences between people who reported high and low levels of social anxiety in a situation designed to evoke high levels of social anxiety. There were a number of hypotheses, including the following:

1. Participants high in social anxiety would show elevated levels of cardiovascular activity during a social stressor, relative to a control condition,

2. Relative to low-anxious participants, those high in social anxiety would show differential patterns of facial action, especially during a relevant social stressor

3. Relative to low anxious participants, those high in social anxiety would show increased evidence of asymmetric expression, especially during a relevant stressor

4. Patterns of facial activity during the social stressor would be related statistically to patterns of physiological activity during the same stressor.

CHAPTER TWO

Methods

<u>Participants</u>:

Participants for this study, 28 females and 26 males, were recruited from the Psychology subject pool at the University of Northern British Columbia. Pre-study screening of participants into groups consisting of individuals who were highly anxious or less anxious was accomplished by administration of the Trait form of the State-Trait Anxiety Inventory (STAI) (Spielberger, Gorsuch, & Luchene, 1970) (See Appendix A) in a battery of screening tests. Participants were categorized into high and low anxious groups on the basis of their scores. People scoring less than 38 were considered to have low anxiety, while people scoring greater than 52 were considered to be highly anxious. Screening of the participants for the study was based on one-half of a standard deviation from the mean score on the STAI (trait), which resulted in 52 participants being initially selected for the study. Upon review of the screening procedure this was further extended to three-quarters of a standard deviation resulting in 32 participants being entered into the final analysis. The suggested cut-off point for high/low scores on this test is one standard deviation, but a limited sampling pool forced a reduction in cut-off points. This extension was done in an attempt to capture a more polar representation of high and low anxious populations, which was initially the intent of the study. Of these 32 participants 21 were male and 11 were female. Also, 17 were rated as highly anxious and 15 scored low on the anxiety screening test.

<u>Instruments & Interviews</u>:

Questionnaires: The Trait form of Spielberger's State-Trait Anxiety Inventory consists of 20 statements (e.g., "I feel nervous and restless") sampled to uncover anxious predisposition content. Respondents indicate the extent to which they generally respond in an anxious way by providing a rating on a four-category scale ("Almost Always", "Often", “Sometimes”, and “Almost Never”). Seven items are reverse scored. The ratings associated with each item are summed to create an overall anxiety score that can range between 20 and 80. The STAI is a widely-used technique of anxiety assessment and has well-established reliability and validity (Spielberger, Gorsuch, & Luchene, 1970).

Favorable impressions interview: The Favorable Impressions (FI) interview is an interpersonally challenging task that elicits social anxiety (Borkovec, Stone, O’Brien & Kaloupek, 1974). During the FI an interviewer of the opposite sex entered the room and sat in front of the participant. The interviewer had been explicitly trained not to respond to the participant in any way (verbally, facial expressions, gestures, etc…). The participant was told beforehand that they would have one minute to create a favorable impression for the interviewer. This section of the study was videotaped.

Control interview: The control interview (CI) consisted of questions about daily events posed by an interviewer to the participant. It was developed to reflect casual conversation. During the CI, the interviewer entered the room and sat across from the participant. They then began engaging the participant for one minute. This section of the study was videotaped. The structure of the CI is given in Appendix B.

Cardiovascular measurements: Systolic blood pressure, diastolic blood pressure, heart rate, mean arterial pressure and inter-beat interval were recorded from each participant via an Ohmeda 2600 Finapres, which employs a finger-cuff method of collecting cardiovascular measurements. The Finapres was connected to a Biopac system operated with Acknowledge 3.0 software. This system provided all cardiovascular measurements on a beat-to-beat basis displayed on a timeline.

Facial measurements: Participants were videotaped during the two interview conditions using a Sony GV-D1000 digital camera. Videotaped interviews were transferred from digital tape to a Pentium III video processing system using the Pinnacle DC2000 video-capture system. These data were entered into Adobe Premiere video-editing tool for further editing into one minute segments equaling the length of each interview.

Specific facial action units (AU's 12/lips turned upward, 15/lips turned down, and 20/corner of mouth pulled sideways) were coded using the Facial Action Coding System (FACS). FACS is a method of quantifying facial movements and expressions into action units (Ekman & Friesen, 1978). Each AU represents the movement of a specific area of the face. FACS is considered an excellent tool for facial measurement and has the benefit of being able to specify facial, gestural, and paralinguistic aspects of interpersonal communication (Buck, 1990). The rationale behind using these facial actions is that they have been identified in several studies as occurring during times of high anxiety (Ekman, 1985; Wallbott & Scherer, 1991; Harrigan & O'Connell, 1996; Ekman & Friesen, 1978). Extensive observation of a pre-existing set of videos showing participants undergoing the FI test also indicated that these actions occurred with high frequency. Facial expressions were coded by a certified FACS proficient coder. Reliability was obtained via the coding of 20 randomly selected data segments by a second FACS proficient coder.

Self-report measures: Four times during the procedure participants were asked to report their current experience on a list of emotions (See Appendix C). This was collected on a seven-point scale for each of surprise, happiness, sadness, fear, disgust, anger, and stress.

The measures were collected at the beginning of the procedure when participants initially arrived at the testing center, after the first interview condition, after the second interview condition, and at the end of the study.

Procedure:

Participants entered the laboratory and were directed to sit down at a table in the testing room. They were given an information sheet, (See Appendix D), a brief description of the study, read and filled out an informed consent sheet, (See Appendix E), and were asked if they had any questions. Participants were then asked to fill out the self-reported emotion scale. Participants were then instructed to move from their seat at the table to a comfortable chair at the other end of the room. The Finapres cuff was then connected to participants' middle finger and recording was initialized. Participants were instructed that they would have a rest period to relax. The first baseline period lasted for twelve minutes after which participants underwent the first interview condition. The sequencing of the interviews was counterbalanced to control for an order effect. In the first condition participants underwent the CI first with the FI second and the order was reversed in the second condition. After participants completed the first interview they were asked to complete a second self-reported emotion scale and there was a second baseline lasting for ten minutes. At the end of the second baseline participants underwent the second interview. Following the second interview participants were asked to fill out a third self-reported emotion scale. They were then instructed that there would be a short resting period and then the procedure would be complete. After a final eight minute recovery period participants were disconnected from equipment and asked to complete a fourth and final emotions scale. Following this, subjects were asked if they had any questions or concerns about the experiment. After the participant's questions had been answered they were thanked for taking part in the study and they exited the testing center.

Table 1. Timeline for Procedure.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18

1. Screening.
2. Selected participants are contacted and invited to participate.
3. Participants are given a brief introduction and asked if they are willing to participate.
4. Participants sign the informed consent sheet.
5. Participants complete the first emotion measure.
6. Participants enter room with randomized test order and are given instructions.
7. Participants are connected to Finapres monitor.
8. Participants are given a 12-minute adaptation period.
9. Participants take part in the first randomized interview.
10. Participants are given the second profile of mood measure.
11. Participants are given a 10-minute adaptation period.
12. Participants take part in the second randomized interview.
13. Participants are given the third profile of mood measure.
14. Participants are given a 10-minute recovery period.
15. Participants are unhooked from the Finapres.
16. Participants are given the fourth profile of mood measure.
17. Participants are thanked for taking part in the study and asked if they have any questions.
18. Participants leave lab.

<u>Data Reduction</u>:

Cardiovascular data: The data were stored as Acknowledge 3.0 data files. These were systematically entered into Mindware analysis software, which analyzes cardiovascular data and calculates numeric values for statistical analyses by ensemble averaging. Data from seven measurement periods (epochs) were averaged. For each condition there were two, one minute baseline segments, one, minute long interview segment (favorable impressions or control interview), and four, one minute recovery segments. Data were reduced in this fashion in order to give a minute-to-minute summary of cardiovascular measures before, during, and after each interview condition, which provides a reflection of the reactive nature as well as the recovery of each participant. Data were then entered into the statistical analysis.

Face Coding Procedure: The baseline and the two minute FI interview were FACS coded for movement, intensity, and asymmetry. The study used FACS coding criteria to identify the AU's. The baseline face coding was used to compare the facial movements of each participant. Each participant received a score for the frequency of each facial action, its intensity, and its asymmetry. Frequency was measured by the number of times an AU was produced. Intensity was calculated by converting the FACS intensity rating system, which uses A (a trace) to E (extreme) categories to an ordinal numeric system from 1 to 5. Asymmetry was scored using the FACS asymmetry scoring method. This rates all unilateral and asymmetric facial expressions. In symmetry analyses, the frequency of asymmetric facial expressions was used as the principal dependent variable.

Self-reported emotion: Scores across each of the four self-reports were summed and entered into Wilcoxon signd rank tests for paired samples.

Overview of Analyses

Facial expressions. The facial expression data were entered into 2 (level of anxiety) by 2 (condition) by 2 (order of interview) repeated measures analyses of variance (ANOVAs), with level of anxiety (high/low) and order as between subjects factors and condition (CI vs. FI) as a within subjects factor. Separate analyses were conducted for the frequency, intensity, and asymmetry of each AU.

Cardiovascular data. To evaluate overall cardiovascular response to each test condition a 2 (level of anxiety) by 2 (order of interview) by 2 (condition) by 7 (epoch) repeated measures ANOVA was employed, with anxiety level as a between subject factor and condition (CI vs FI) and epoch (two baseline, one interview, and four recovery measures) entered as within subject factors.

To analyze cardiovascular reactivity a regression analysis was used by entering the participants' baseline score as a predictor and their reactivity change score as the Y value resulting in a residual score for each participant. The reactivity change score was calculated by subtracting the average systolic and diastolic blood pressure during both interview conditions from the average baseline value. The same technique was used to convert heart rate measurements to reactivity scores. The residual score from each participant represented the amount of change from their baseline, adjusted for initial level. The residual score, for each condition, was entered into repeated measures ANOVAs with the residual score entered as the dependent variable and level of anxiety and interview order being entered as between subject factors. Tukey B Tests were conducted on all significant relationships where anxiety was a factor.

The analysis of cardiovascular recovery was conducted by first calculating the slope of the four recovery measures for each of the interview conditions. This resulted in a single recovery value for each condition. A 2 (level of anxiety) by 2 (condition) by 2 (order or interview) repeated measures ANOVA was conducted on recovery slope measures, with anxiety level (high anxious or low anxious) entered as a between subject factor and condition (CI vs FI) entered as a within subjects factor

Emotion ratings. Self-reported level of emotional experience data were analyzed by using a Wilcoxon signed rank test for two paired samples (Hurlburt, 2003). Scores from self-reports immediately after the control interview and the favorable impressions interview were compared.

Correlational analyses. The second phase of the analysis consisted of conducting chiefly exploratory post-hoc correlations on the dependent variables in an attempt to determine possible relationships between them. Relationships between facial expression, cardiovascular functioning, and self-reported levels of emotion during the control interview and the favorable impression interview were entered into bi-variate correlations using Kendall's tau-b variation for non-parametric data.

CHAPTER THREE

Results

Data Cleaning Procedure

Before conducting statistical analyses the data for all dependent variables were examined for missing values, outliers, and normality. Several of the variables, did possess extreme outliers, defined as any score that deviates more than three standard deviations from the mean (Tabachnik and Fidell, 2001). The dependent variable where the participant's lips were turned downward (AU 15) in an asymmetric fashion possessed several outliers during the control interview and in the favorable impression interview. These two dependent variables were entered into a non-parametric Mann-Whitney test. All other variables were within acceptable outlier parameters. With the exception of AU15 all face and cardiovascular data were also within acceptable standards for skew and kurtosis (Tabachnik and Fidell, 2001). Many of the self-reported emotional experience dependent variables deviated from normality, so these data were entered only into non-parametric analyses. See Tables 2, 3 & 4 for the descriptive statistics relating correspondingly to the face data, cardiovascular data, and the self-reported levels of emotion.

Table 2

Descriptive Statistics for Facial Expressions

Facial Measurement	Mean CI	Mean FI	Standard Deviation CI	Standard Deviation FI	Range CI	Range FI	Skew CI	Skew FI	Kurtois CI	Kurtois FI
Lip corners turned upward (AU12)										
Frequency	5.78	7.5	3.94	3.81	16	14	0.69	0.36	-0.14	-0.78
Intensity	2.01	2	0.6	0.54	3	2.3	-1.04	0.36	2.56	-0.04
Asymmetry	0.37	0.62	0.69	0.96	3	4	2.22	1.73	2.45	3.2
Lip corners turned down (AU15)										
Frequency	0.96	1.81	1.44	2.35	5	10	1.74	2.22	2.24	2.87
Intensity	0.74	1.28	0.86	0.96	2.4	3	0.6	-0.1	-1.3	-1.21
Asymmetry	0.06	0.21	0.24	0.73	1	4	3.79	4.49	13.22	22.03
Lips pulled laterally (AU20)										
Frequency	3.15	4.46	2.48	2.87	8	0.12	0.45	0.83	-0.91	0.39
Intensity	1.6	2.01	0.96	0.66	3.5	3.3	-0.06	-0.6	-0.57	1.41
Asymmetry	1.12	1.37	1.53	1.94	5	7	1.24	1.56	0.25	1.57
Total frequency	9.9	13.78	4.98	6.4	19	21	0.17	0.64	-0.51	-0.94
Total intensity	4.35	5.3	1.66	1.67	7.1	7.16	0.41	-0.1	-0.08	-0.28
Total asymmetry	1.56	2.21	1.78	2.55	7	8	1.26	1.17	1.16	0.08

Table 3

Descriptive Statistics for Cardiovascular Data

Cardiovascular measure	Mean CI	Mean FI	Standard Deviation CI	Standard Deviation FI	Range CI	Range FI	Skew CI	Skew FI	Kurtois CI	Kurtois FI
Systolic blood pressure (mmHg)	139.71	159.24	17.88	22.64	65.91	81.7	0.44	0.41	-0.62	-0.85
Diastolic blood pressure (mmHg)	79.85	94.99	18.02	20.04	99.73	80.3	-1.36	1.22	2.88	1.09
Heart rate (bpm)	85.65	96.58	10.32	17.39	43.87	67.1	-0.17	0.2	-0.29	-0.63
Cardiovascular recovery Slope of recovery										
Systolic blood pressure	-2.78	-5.01	2.75	3.29	10.35	13.9	-0.12	-0.71	-0.33	0.06
Diastolic blood pressure	-1.54	-2.61	1.65	2.81	7.11	15.5	-0.28	-0.52	0.33	2.35
Heart Rate	-0.81	-2.82	2.73	4.07	15.29	23	2.04	1.36	1.78	2.46
Cardiovascular reactivity Amplitude of response										
Systolic blood pressure (mmHg)	13.58	24.36	11.12	20.71	48.45	103	0.96	1.13	0.96	2.7
Diastolic blood pressure (mmHg)	9.44	14.78	9.01	10.67	44.23	44.8	1.9	0.77	4.4	0.47
Heart rate (bpm)	8.71	12.71	4.98	10.19	17.44	44.4	0.2	0.35	-0.99	0.051

Table 4

Descriptive Statistics for Self-Report of Emotions

	Mean		Standard Deviation		Range		Skew		Kurtois	
Seven-point scale	CI	FI	CI	FI	CI	FI	CI	FI	CI	FI
Surprise	1.81	3.68	1.63	1.31	6	5	0.69	-0.4	-0.08	-0.34
Happiness	0.56	0.62	1.11	1.15	5	4	2.51	2.01	7.48	3.28
Sadness	0.15	0.21	0.57	0.79	3	4	4.37	4.14	20.62	18.02
Fear	2.43	4.78	1.81	1.89	7	7	1.02	-1.2	0.65	1.11
Disgust	0.81	2.06	1.17	2.01	4	6	1.14	0.38	0.19	-1.45
Anger	0.37	0.31	0.91	0.89	4	4	3.02	3.33	9.49	11.15
Stress	4.12	3.31	1.99	1.61	6	6	-0.18	-0.2	-1.14	-0.89

Facial expression

Reliability for all facial expression data was achieved at a level of R = 0.87 between the two coders.

For the facial expression data the repeated measures ANOVAs revealed several interesting results. For the intensity of AU 15 (lip corners turned down) there was a significant difference between the two interview conditions, F (1, 28) = 6.51, $p < .05$, $\eta^2 = .19$. The mean intensity of AU15 during the FI (M=1.28, SD=0.96) exceeded (M=0.74, SD=0.86) during the CI.

The analysis of the frequency of AU 20 revealed a significant condition effect, F (1, 28) = 6.89, $p < .05$, $\eta^2 = .19$ and a significant anxiety group effect, F (1, 29) = 4.31, $p < .05$, $\eta^2 = .14$. There was a significant increase in the frequency of AU 20 between the CI (M=3.15, SD=2.48) and the FI (M=4.46, SD= 2.87). Those that were in the low anxiety group: CI (M=4.01, SD=2.77); FI (M=5.46, SD=2.92) produced AU20 at a significantly higher frequency than the highly anxious: CI (M=2.41, SD=2.09); FI (M=3.58, SD=2.69), (see Figure 1).

The analysis of total frequency of facial actions resulted in a significant interview effect, F (1, 28) = 11.42, $p < .01$, $\eta^2 = .29$, reflecting an increase in facial movement during the FI, (M=13.78, SD=6.4) relative to the CI (M=9.91, SD=4.98). The analysis of total intensity of expressions resulted in a significant interview effect, F (1, 28) = 13.13, $p < .01$, $\eta^2 = .31$ and a significant interview X anxiety group interaction, F (1, 28) = 5.42, $p < .05$, $\eta^2 = .16$. Highly anxious participants produced overall more intense facial expressions than did those who were low in anxiety. The high anxiety group: CI (M=4.08, SD=1.80), FI (M=5.58, SD=1.62) produced more intense facial expressions than the low anxiety group: CI (M=4.66, SD=1.56), FI (M=4.98, SD=1.78). Figure 2 shows that those in the low anxiety group overall produced facial expressions at approximately equal intensity between the two interview conditions, whereas those in the high anxiety group tended to have a discrepancy in intensity between the two interview conditions. A Tukey B test showed that the difference in expression intensities were significantly different between the two interviews in the highly anxious. Overall there were more intense facial expressions produced during the favorable impression interview. A Mann-Whitney U Test conducted on the asymmetry of AU 15 revealed a significant difference between the frequencies of asymmetric expressions produced during the FI. Figure 3 shows that during the FI, highly anxious participants produced a higher frequency of asymmetric AU 15. $U = 97.50$, $p < 0.05$.

Cardiovascular data

The analysis of cardiovascular responses revealed several significant results. The ANOVA for systolic blood pressure resulted in significant main effects for interview, $F(1, 28) = 26.46$, $p < .001$, $\eta^2 = .48$, and epoch, $F(3.31, 98.93) = 34.54$, $p < .001$, $\eta^2 = .56$. There was a significant interview X anxiety, $F(1, 28) = 6.52$, $p < .05$, $\eta^2 = .19$, effect. Figure 4 shows that the highly anxious group had higher blood systolic blood pressure during both interviews. There was also an interview X order, $F(1, 28) = 8.91$, $p < .01$, $\eta^2 = .25$, Figure 5 shows that participants who were in the FI first condition had elevated blood pressure during the first interview, but it decreased in the second interview, whereas no effects were evident for the CI first group. There was an epoch X order effect, $F(3.31, 98.93) = 3.22$, $p < .05$, $\eta^2 = .11$, effect. Overall, systolic blood pressure was elevated in participants undertaking the FI task first, and anxious participants reacted to the FI task with elevated systolic blood pressure.

The analysis for diastolic blood pressure resulted in significant main effects for anxiety group, F (1, 28) = 7.34, $p < .05$, $\eta^2 = .21$, interview, F (1, 28) = 15.81, $p < .001$, $\eta^2 = .36$, and epoch, F (2.20, 62.26) = 14.21, $p < .01$, $\eta^2 = .34$, and a significant interview X order interaction, F (1, 28) = 11.44, $p < .01$, $\eta^2 = .29$. Figure 6 shows elevated levels of diastolic blood pressure in both interview conditions if participants were in the FI first group, but, lower initially in the CI first group and elevating with the onset of the FI task. Diastolic blood pressure was higher during the FI than during the CI (Figure 7). Those who were in the high anxiety group showed higher diastolic blood pressure in both interviews (Figure 7).

The next step of the analysis evaluates differences in cardiovascular reactivity and recovery parameters, as described in the method section.

Reactivity. Repeated measures ANOVAs found no significant differences between or within groups for systolic blood pressure, diastolic blood pressure, or heart rate.

Recovery. There were several significant results in the analyses of rate of recovery from the interview conditions. For systolic blood pressure, there was a significant interview condition effect, F (1, 28) = 14.23, $p < .01$, $\eta^2 = .64$. Participants in both groups showed larger systolic blood pressure recovery from the FI interview. See Figure 8 for an illustration of the differences, showing that the higher anxiety participants' blood pressure showed a larger reduction. There were similar results for the recovery of diastolic blood pressure with larger recoveries in the favorable impression interview. $F_{1, 30} = 3.97$, $p < .05$, $\eta^2 = .13$, although effects for anxiety group were not present.

The analysis of heart-rate recovery resulted in a significant main effect for interview, $\underline{F}$ (1, 28) = 13.75, $\underline{p} < .001$, $\eta^2 = .33$, and a significant interview X anxiety group interaction, $\underline{F}$ (1, 28) = 11.87, $\underline{p} < .01$, $\eta^2 = .29$ Highly anxious participants had greater heart-rate recovery than low anxious participants during the favorable impression interview (See Figure 9). Highly anxious participants also had a higher level of heart-rate recovery when they were in the FI condition than the CI condition. The slope of Heart rate recovery was much greater for the favorable impressions interview.

<u>Self-Reported Levels of Emotion</u>

The results of the Wilcox test for two related samples, indicated significant between-interview results for self-reported reported stress, surprise, and fear < $\underline{p}$ 0.05. Figure 10 shows that those in the high anxiety group reported less stress in both interview conditions. Similar trends were shown with the self-reporting of surprise and fear. See figures 11 and 12.

<u>Post-hoc correlations relating dependent variables to anxiety level</u>

A series of non-parametric correlations were computed between dependent variables to attempt to discover further relationships. It was hypothesized that there would be relationships between these variables, but since some variables did not meet parametric standards a non-parametric correlation was used. The key to this analysis was to correlate the participants' facial expressions, cardiovascular response, and self-reports of emotion to their anxiety scores on the STAI. For facial action units there was a significant positive correlation between anxiety scores and action unit 20 during the favorable impression interview (r =0 .39, $\underline{p}$ = .029). There was a positive correlation between increase in heart rate and the frequency of AU 12 during the FI interview (r =

0.29, $p = 0.026$). Also, another positive correlation evident was found between heart rate and the intensity of AU 15 ($r = .31$, $p = 0.024$).

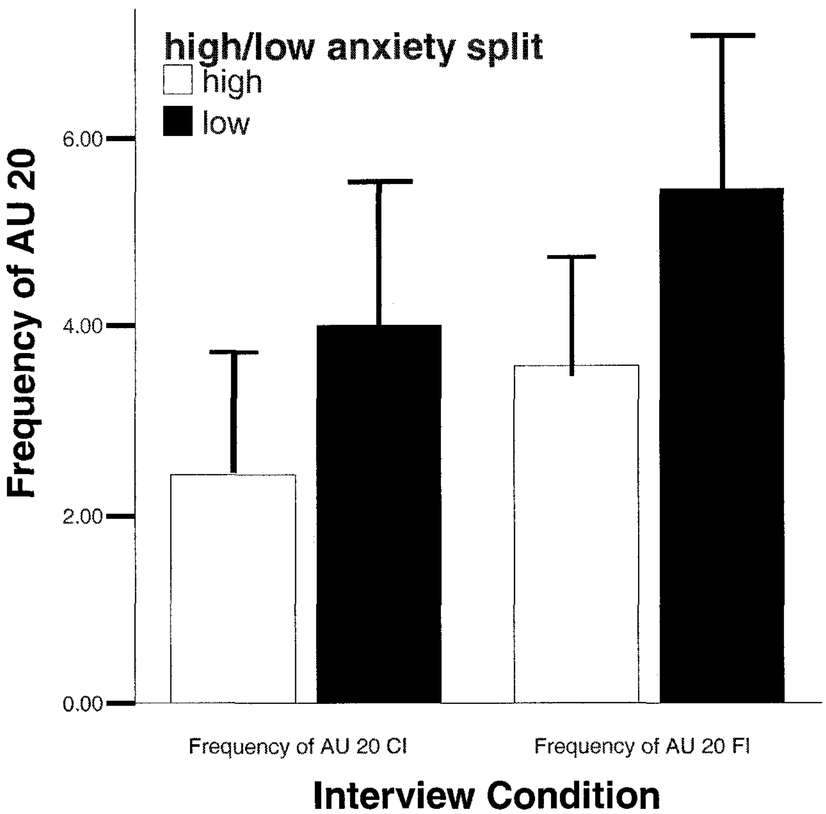


Figure 1. Difference in the mean frequency of lateral mouth movement between high and low anxiety participants during the control interview (CI) and the Favorable Impression task (FI).

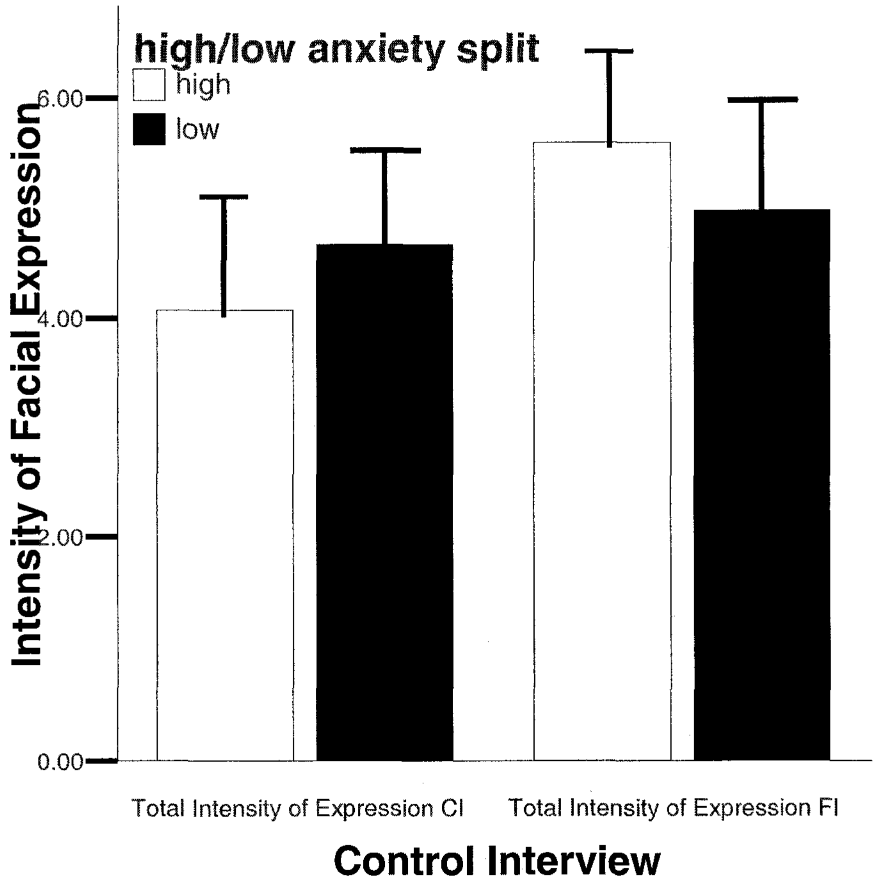


Figure 2. Difference in the mean intensity of all action units between high and low anxiety participants during the control interview (CI) and the Favorable Impression task (FI).

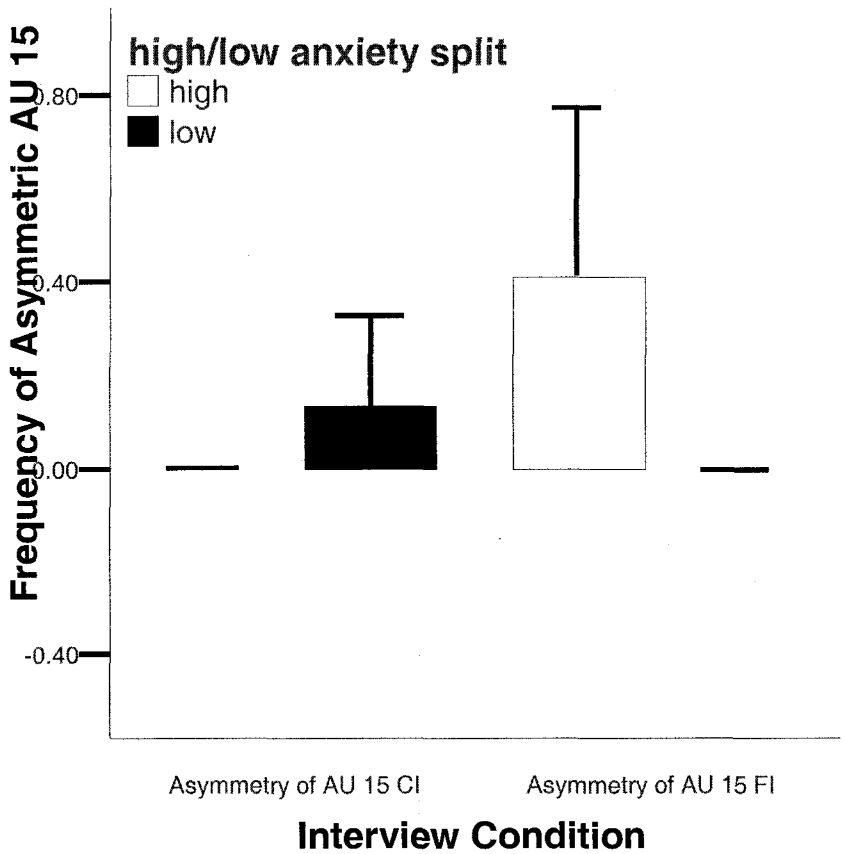


Figure 3. Differences in the mean frequency of asymmetric facial movement for downward movement of the mouth between high and low anxiety participant during the control interview (CI) and the Favorable Impression task (FI).

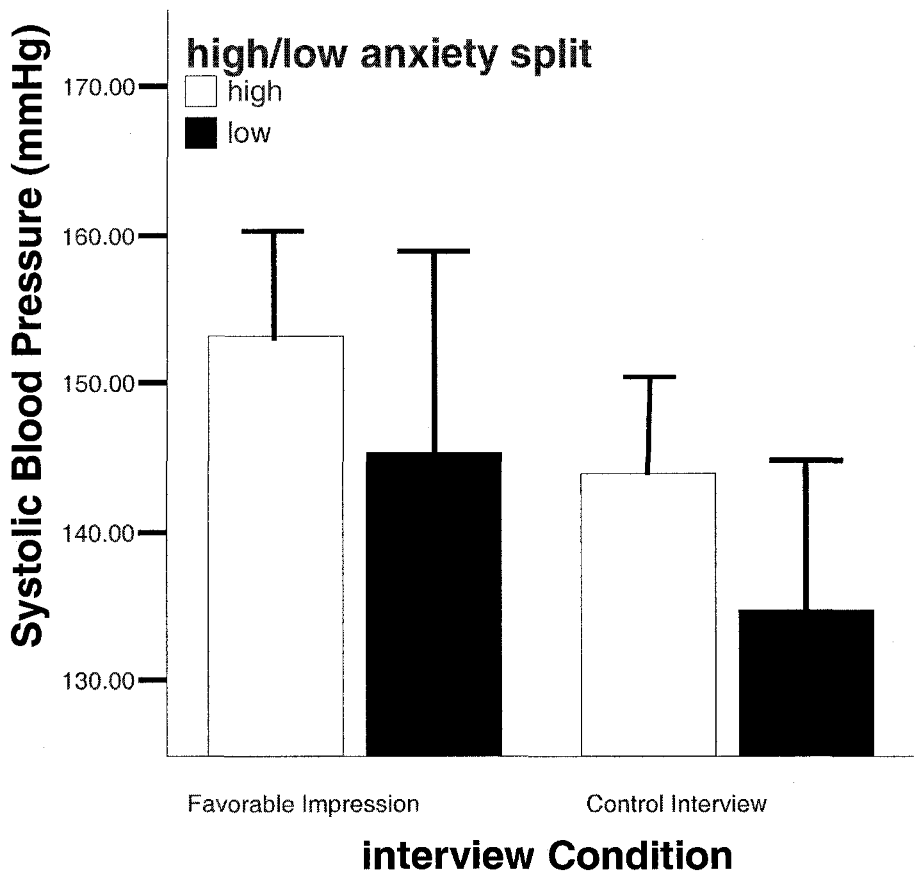


Figure 4. Differences in systolic blood pressure between high and low anxiety group for each interview condition.

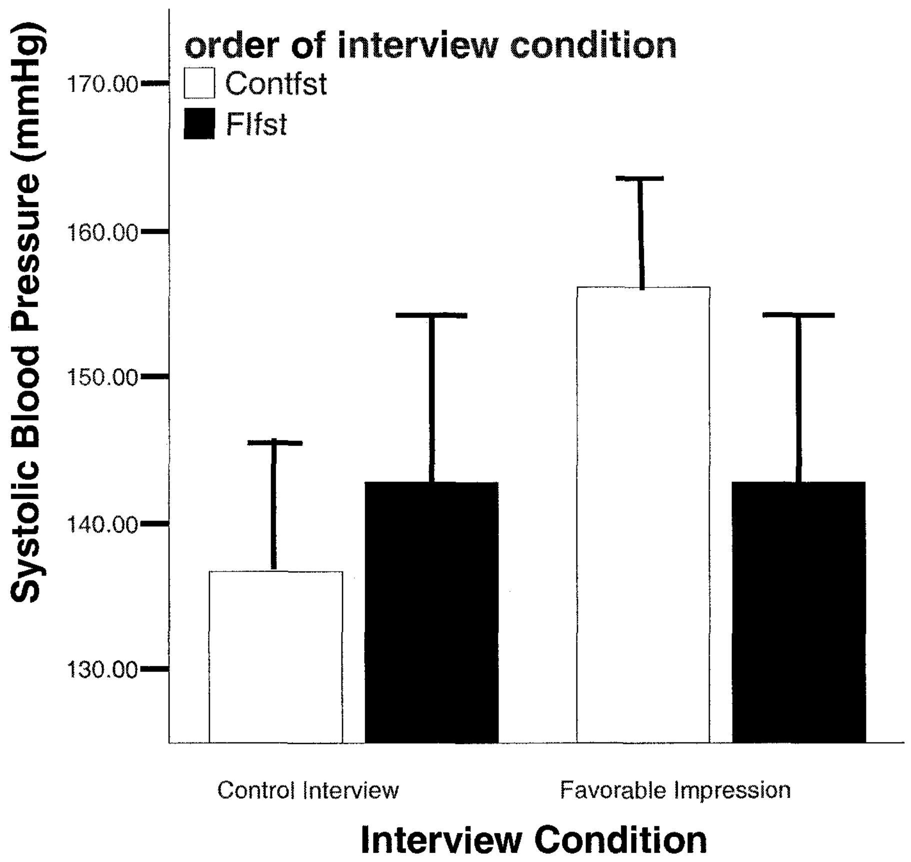


Figure 5. Differences in systolic blood pressure between interviews depending on which interview was completed first, the control interview (CI) or the favorable impression (FI).

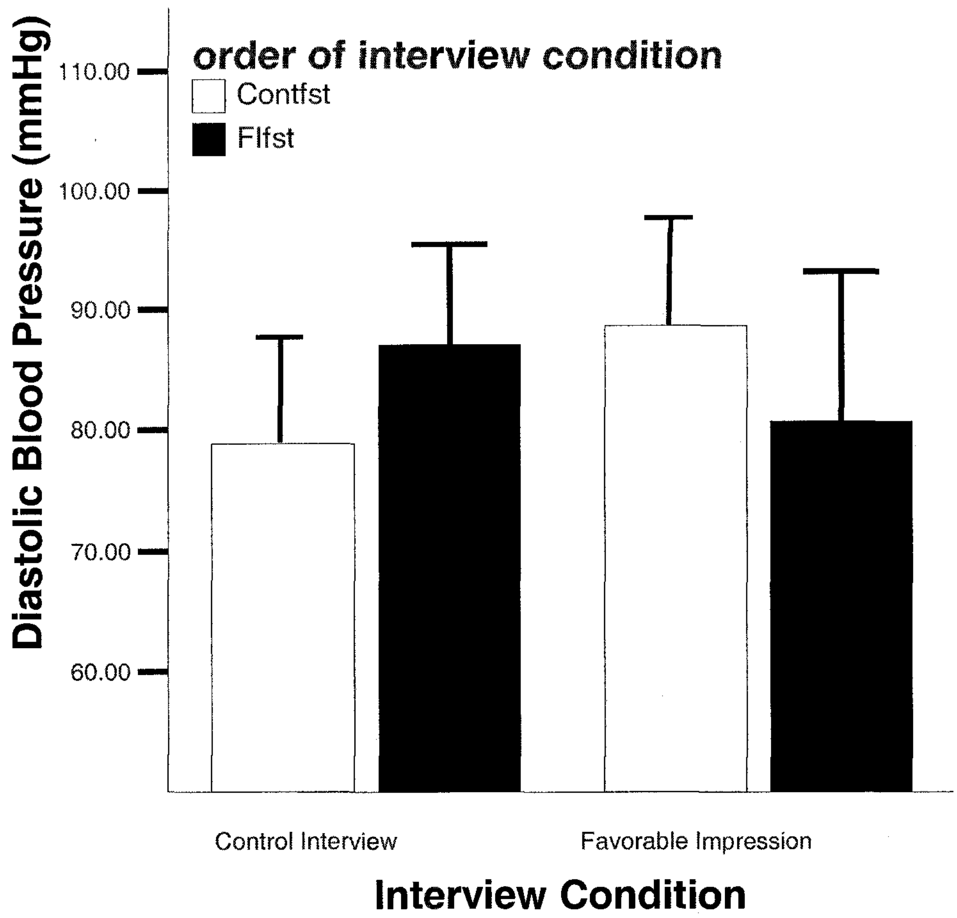


Figure 6. Differences in diastolic blood pressure between interviews depending on which interview was completed first, the control interview (CI) or the favorable impression (FI).

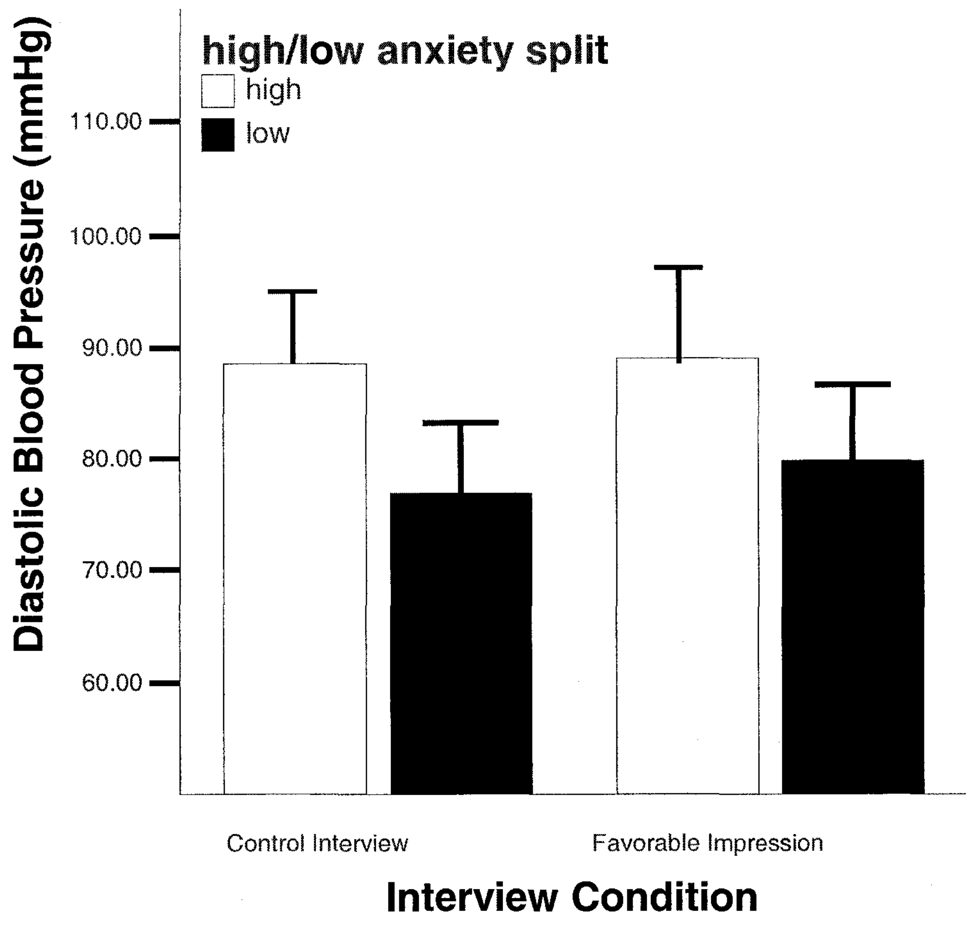


Figure 7. Differences in mean diastolic blood pressure between high and low anxiety participants during each interview condition.

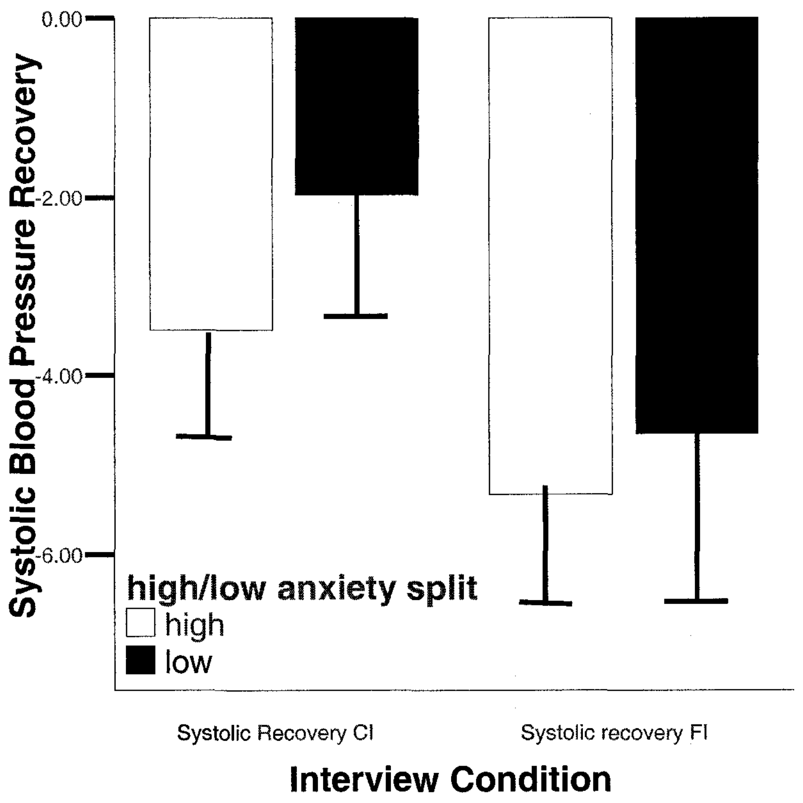


Figure 8. Mean difference systolic blood pressure recovery scores, based on the slope of recovery, between high and low anxiety participants during the control interview (CI) and the Favorable Impression task (FI).

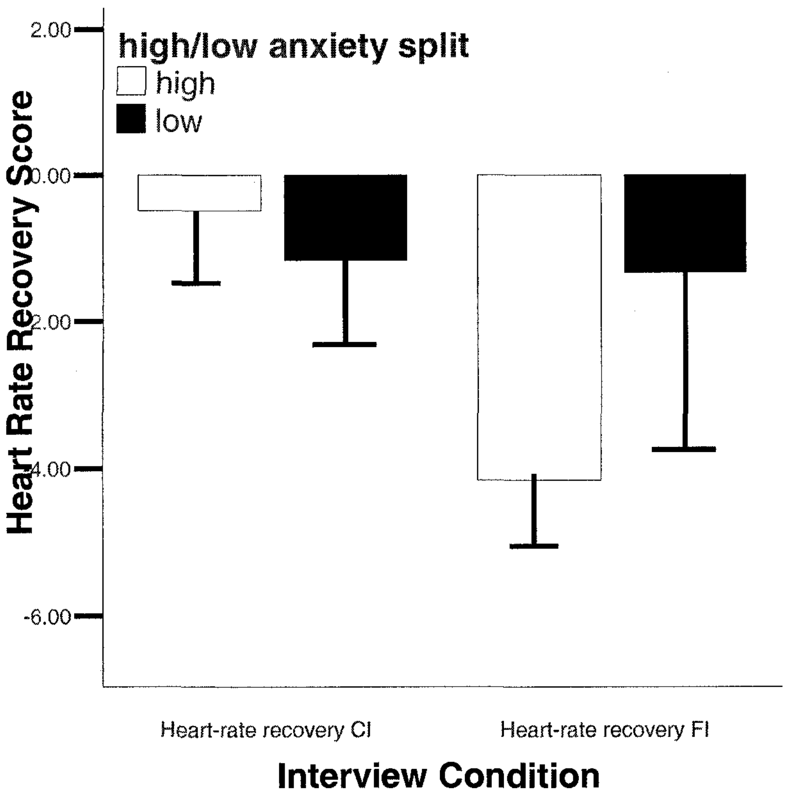


Figure 9. Differences in mean heart rate recovery based on the slope of recovery, between high and low anxiety participants during the control interview (CI) and the Favorable Impression task (FI).

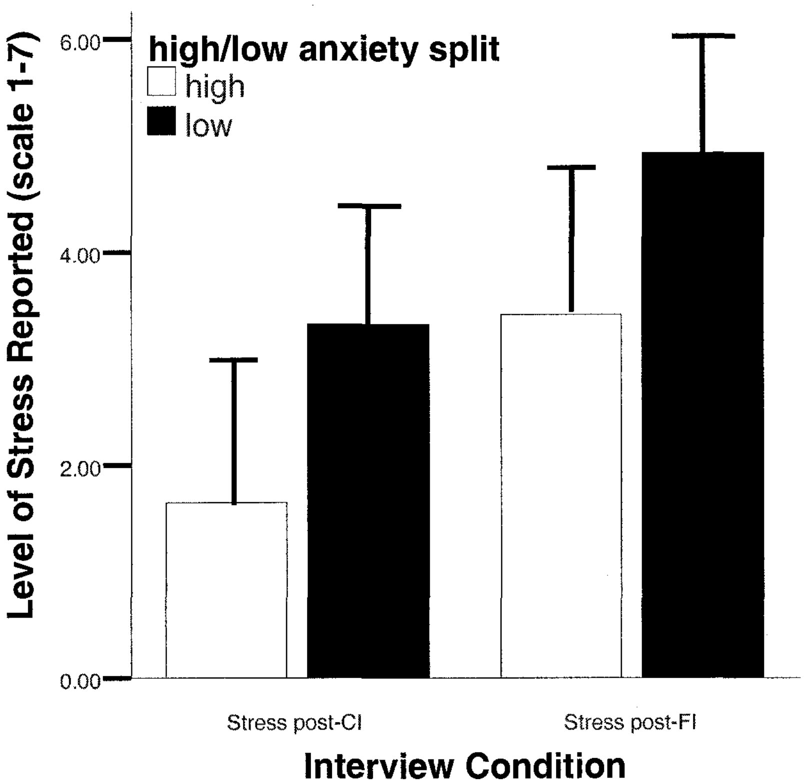


Figure 10. Mean differences in the self-reported levels of stress between high and low anxiety participants during the control interview (CI) and the Favorable Impression task (FI).

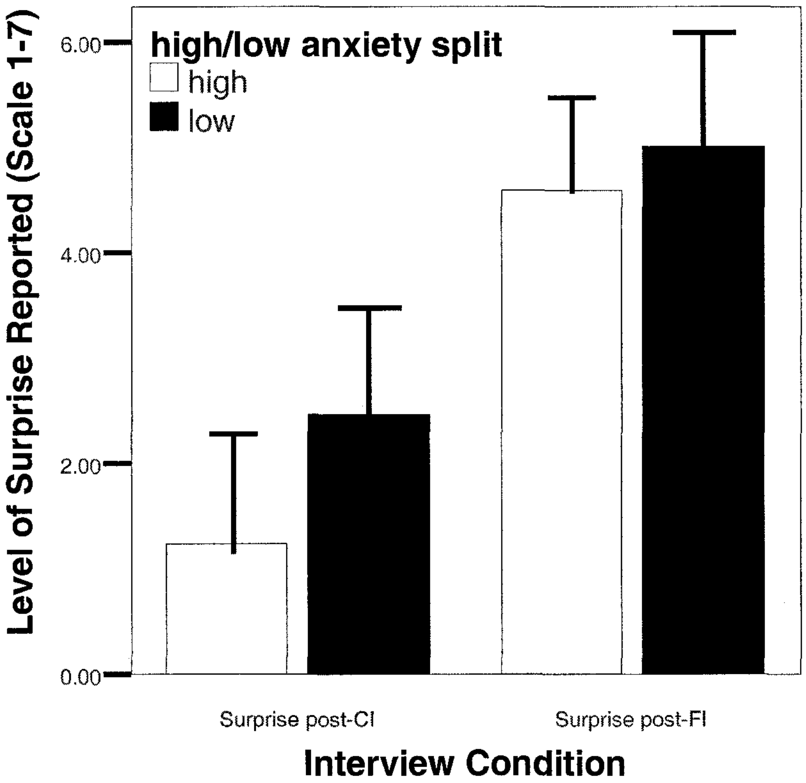


Figure 11. Differences in self-reported levels of surprise between high and low anxiety participants during the control interview (CI) and the Favorable Impression task (FI).

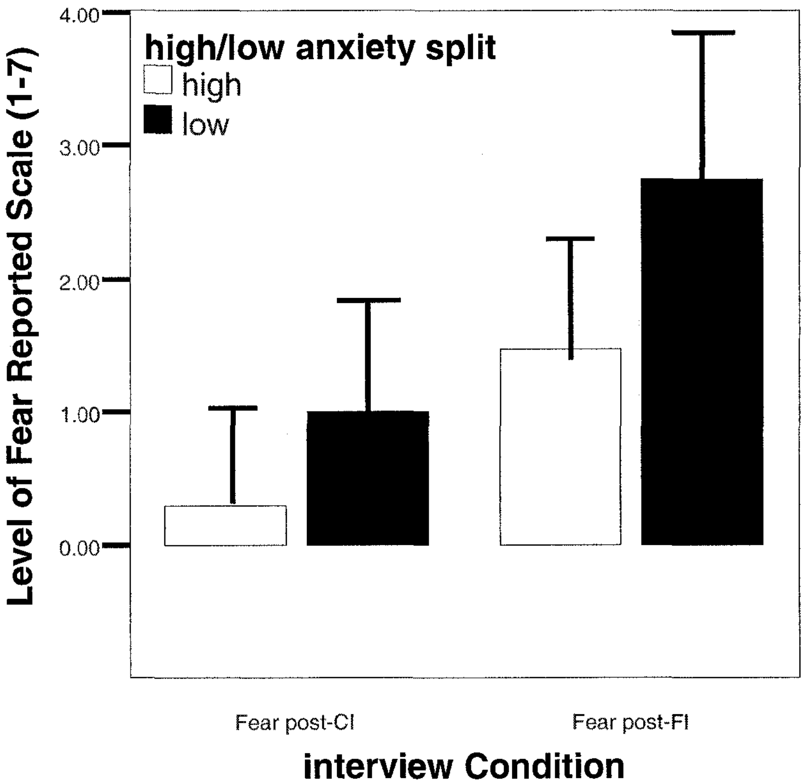
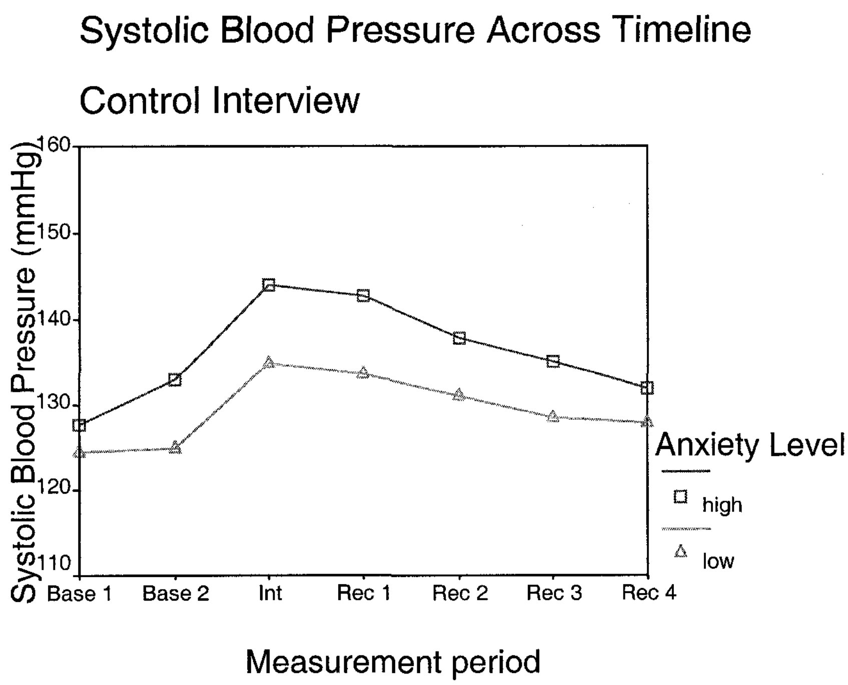


Figure 12. Mean differences in self-reported levels of fear between high and low anxiety participants during the control interview (CI) and the Favorable Impression task (FI).



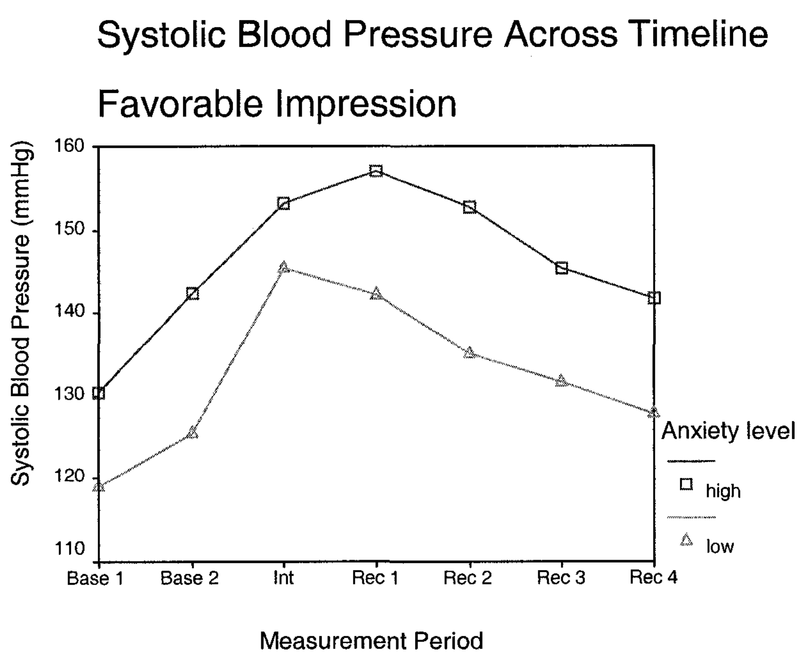
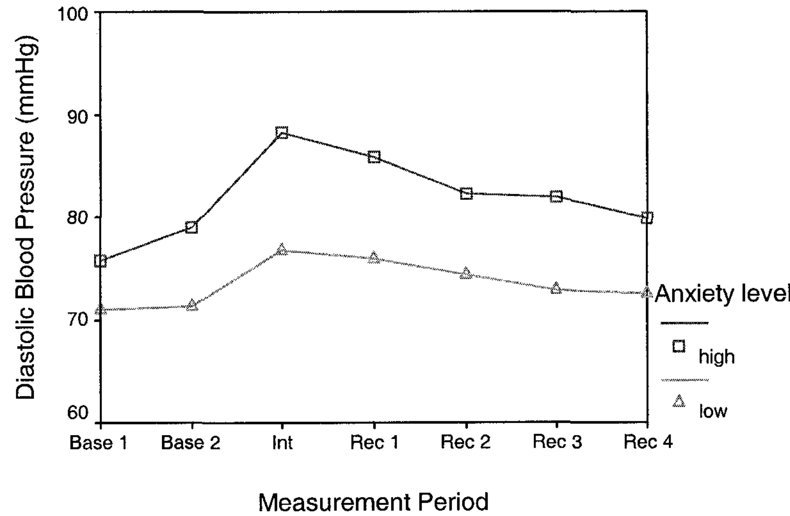


Figure 13. Overall systolic blood pressure differences between high and low anxiety participants for each interview condition.

Diastolic Blood Pressure Across Timeline

Control Interview



Diastolic Blood Pressure Across Timeline

Favorable Impression

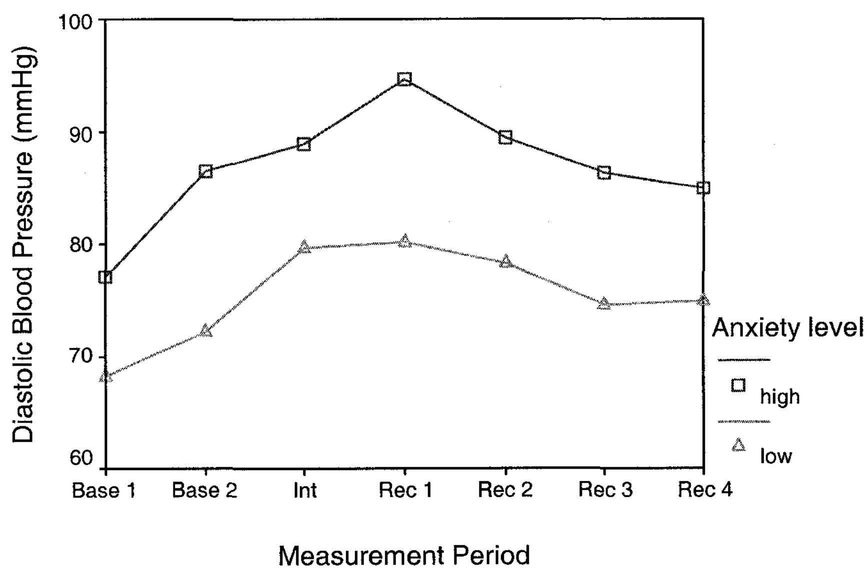


Figure 14. Overall diastolic blood pressure differences between high and low anxiety participants for each interview condition.

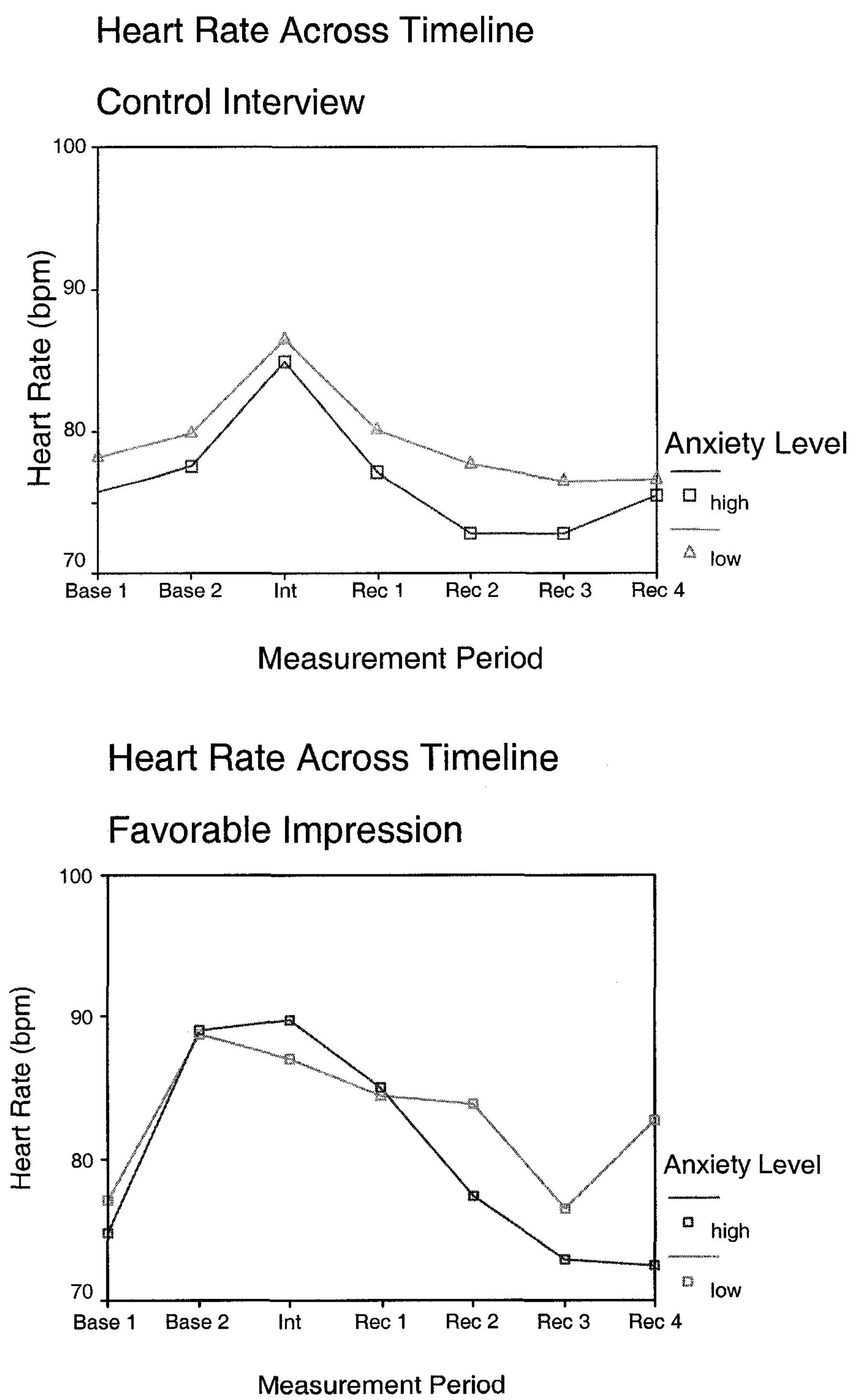


Figure 15. Heart rate differences between high and low anxiety participants for each interview condition.

CHAPTER FOUR

Discussion

Overview of the Results

In this study, participants' responses to a socially challenging situation were investigated. The ultimate goal was to gain a better understanding of differences between how high/low anxiety groups react to a stressful event and attempt to find relationships between behavioral, physiological, and self-reported variables. Cardiovascular responses, which included systolic blood pressure, diastolic blood pressure, and heart-rate, were measured. Facial movement around the mouth area including upwards, lateral, and downward movements were measured as a second set of dependent variables. The final variable set was the self-reports of emotional states, which included the participants' current level of happiness, sadness, anger, fear, surprise, disgust, and stress. These variables were measured in an attempt to determine differences in emotional reactivity between these groups in the various settings. It was hypothesized that there would be differences in cardiovascular responses between high and low anxiety individuals. It was also hypothesized that there would be differences in expressive facial movements, in particular, asymmetric movements of the mouth. A third hypothesis stated that there would be a relationship between levels of anxiety, behavioral data, cardiovascular data, and self-report data. The three hypotheses were generally supported by the data.

Overall, there were differences in facial AU's between the interview conditions demonstrating that varying social situations can elicit different behavioral responses from individuals, even when the environment is similar. More importantly, there were differences in facial AU's between high and low anxiety participants suggesting that behavioral differences may be paramount to defining markers for the anxiety prone. One difference between the different groups in this study was that highly anxious participants produced fewer facial expressions, but during the FI interview the high anxiety participants' facial expressions became much more intense. This could, perhaps, reflect a leak in that individual's coping mechanism. This suggests that it is easier to modulate a motionless face; whereas once a facial motor program has been initiated facial expressions may be more difficult to control, which would result in more intense facial action. This could be a possible link to the identification of highly anxious people through facial analysis.

There were differences in blood pressure between the high and low anxiety participants in the data. Figures 13 and 14 shows that the highly anxious participants had higher blood pressure during each measurement period. The elevated levels in blood pressure demonstrated by the highly anxious participants may have been due to them being engaged in a laboratory environment. The interview order effect probably contributed to overall higher responses but, some researchers have found similar results (Sawada, 2003; Goldstein & Shapiro, 2000; Nyklicek, Vingerhoets, Van Heck, & Van Limpt, 1998). These findings, along with the results of the present study, do suggest that elevated levels of anxiety are related to higher blood pressure, both systolic and diastolic.

Figure 15 shows small heart-rate differences between the high and low anxiety participants existed during basal and interview measurement periods. After the favorable impression interview, participants who were highly anxious showed more rapid heart rate recovery. This could reflect an overactive ANS response to an external stressor, namely, an awkward social interaction. Perhaps the vagal influence in these individuals is more reactive, causing constant heart changes. Porges (2001) suggests a vagal "braking" process that exercises itself on heart activity. There may be over-activity in vagal reactivity resulting in exaggerated reactions. This could be influenced by some, perhaps, perceptual, or high-order processing. Perhaps the key to understanding recovery from a stressful event is to accurately measure and analyze changes in SNS and PNS influences on the heart.

Participants' self-reports of emotion revealed that those who were highly anxious tended to report lower levels of emotion than less anxious participants. This result was significant for the participants' reports of stress, surprise, and fear with the less anxious group reporting lower levels of all three measures. Lower reports of emotion by the highly anxious participants could reflect their heightened sense of impression management. Perhaps their lower scores could reflect a form of social paranoia experienced by the highly anxious participants, resulting in them reporting lower levels of emotion. Their fear of a possible embarrassing situation is reflected in them modulating the report of their experience. As suggested by Edelmann (1987), the socially anxious fear embarrassment because they do not know how to act in a given situation, and have learned from past experience that their behavior tends to be inadequate. This suggests that the socially anxious person is aware of their self-perceived social shortcomings and therefore reduces the level of emotion that they are reporting so as not to seem highly emotional. It was suggested by Zimbardo (1977) that those who are socially anxious tend to be inhibited and overly concerned about their public image.

Facial Expressions Marking Emotional Experience

Facial expressions are reported to relate to the internal experience of the individual producing them. Varying degrees of facial expressivity reflect how a person is coping with their surroundings. Facial expressions send information, intentionally and non-intentionally, to all those within viewing range on the intent, experience, and emotions of the individual producing them. As suggested by Izard (1994) facial expressions play a component part in emotional experience, but are also subject to modification in social environments. Within certain social contexts an individual may alter their facial expressions to disguise their true emotional experience. From an evolutionary standpoint, it is advantageous to be able to modulate one's facial expressions because in certain social interactions displaying one's 'true' emotional experience is not desirable. For example, showing fear during a territorial conflict may lead to an attack from a rival that would not have attacked otherwise. Relating to interpersonal anxiety, displaying facial expressions reflecting distress may lead to unfavorable social outcomes such as loss of social status or perceived self-worth.

In most cases people can modulate their facial movements to create an impression on others. This does not seem to be the case with those who are highly anxious. Overall, across several of the measures, levels of facial expression were more frequent, intense, and asymmetric during the anxiety provoking condition. The cardiovascular measures used in this study indicate a higher level of arousal for anxious people. It would seem that high levels of arousal displayed by highly anxious people predispose them to show higher intensities of facial movement. It could be that highly anxious people experience such a high level of arousal that it results in anxious facial expressions "leaking" during their social expressions. This idea is supported by the findings that show an increase in the intensity of the facial expressions measured during the favorable impressions condition.

When an individual is experiencing stress their levels of arousal undoubtedly increase. According to Ekman, felt expressions of emotion, as opposed to posed expressions, occur involuntarily, without thought or intention (Ekman, 1985). These facial actions can, perhaps, override other facial actions that are being produced in a voluntary manner. It may be that when the highly anxious participants produced facial expressions, their initiation of facial movement may trigger a sort of cascading motor reaction resulting in more intense facial movement. Those who are predisposed to higher levels of trait anxiety show more intense facial expressions during a stressful event compared to their facial expressions during a less stressful event marking their increased arousal.

Ferndandez-Dols and Ruiz-Belda (1997) suggested that expressions of non-specific emotion, even very intense emotion, occur in a disorganized manner outside of social contexts. Within a given social arena there will be prototypical facial expressions that are produced to communicate emotional experience to others. These learned expressions occur as part of a social affect program and function as a communicative aspect of emotional experience. The importance of studying spontaneous expressions relates to the idea that spontaneous expressions are beyond an individual's conscious control and therefore may accurately represent one's true emotional experience. Ekman (1985) also maintains that many spontaneous expressions occur in facial actions that cannot be voluntarily controlled, therefore when they occur it is usually the result of an increase in affective responsiveness. Put simply, the more emotionally aroused a person becomes, the more it will be evident in their facial expressiveness either through an increase in frequency, intensity, or asymmetry.

Differences in facial behavior between different populations, in the case of high and low anxious individuals, may provide insight into the identification of those who may have a higher risk of developing later develop health problems (e.g. hypertension or other cardiovascular illness). In relation to the current study, there were differences between high and low anxious participants in how intense each of the measured AU's occurred. Low anxious participants' overall facial expression intensities were relatively unchanged between the two interview conditions, but participants scoring high on anxiety measures showed significantly more intense expressions during the stress-inducing condition of the study. This demonstrates one difference between high and low anxious people between the two interview conditions.

Another significant difference between the high and low anxious groups occurred in the asymmetric downward movement around the corners of the mouth. The action unit 15 has been associated with distress (Nakamura, 2002; Ekman, 1978). Those who were highly anxious showed more asymmetry of AU15. There were no other significant differences between the interview conditions, suggesting that highly anxious people tend to produce more asymmetric expressions relating to distress in all situations. Research conducted by Rozin and Cohen (2003) showed that during natural conversation in a non-provoking environment there were no significant increases in facial asymmetry. An interesting finding from this work was the fact that the emotions that tended to be judged by observers and subjectively rated by participants as negative displayed more intense asymmetry in the left hemi-face. This suggests that there may be a connection between negative affect and facial asymmetry. Ekman (1985) reported that posed facial expressions do appear to be more asymmetric and spontaneous expressions tended to be less asymmetric. This still may lead to the assumption that in some cases asymmetric facial expressions, particularly around the mouth area, may act as an indicator, perhaps at the person's unconscious level, of distress.

Much of the work conducted in this area has not provided concrete models of brain asymmetry, leaving researchers to formulate their own hypotheses regarding facial asymmetry. Even though it has been demonstrated that there are hemispheric asymmetries in brain functioning the work to date is still relatively theoretical and requires more research attention. Simplistic models of approach/avoidance asymmetries in the brain provide a basis from which researchers can begin to delineate the nature of the relationship between brain functioning, brain asymmetries, and functional asymmetries, but these models only provide a rudimentary outline for probably much more intricate brain processing. There are obviously many brain systems working in concert when a reaction to any stimulus occurs, and it may be the case that there are varied levels of brain asymmetry across all of the systems. The understanding of where asymmetries may be present in the brain is relatively basic, but by analyzing behavior researchers may begin to understand and uncover some of the relationships.

Anxiety and Cardiovascular Measures

It is important to pay attention to cardiovascular reactions to different situations because of the emerging evidence of a relationship between emotional experience and cardiovascular illness (Rosenberg & Ekman, 2001; Monk et al., 2001; Davidson et al., 1994). For example, in past research (Friedman & Thayer, 1998) highly anxious participants were subjected to shock avoidance and cold pressor tests. Highly anxious participants could be identified strictly on the basis of their cardiovascular responses. Highly anxious participants showed higher blood pressure during both tasks. The relationship between anxiety and heart rate reactivity was not discovered in this study, but there was a difference in recovery between high and low anxiety groups.

This exaggerated recovery response could reflect autonomic functioning. Specifically, when faced with a situation that increases stress the highly anxious person's parasympathetic nervous system (PNS) may apply its effects to the cardiovascular system more vigorously, resulting in a more rapid reduction of heart rate after the stress is terminated. Researchers have shown that the PNS exercises its control over the heart at the sinotriatal node via the vagal nerve and by inhibiting the sympathetic nervous system at the medullar level (Opie, 2004). Researchers have also demonstrated that the sympathetic nervous system (SNS) plays only a minor role in reducing heart rate, only by reducing its impact on the heart thereby reducing heart-rate, and is more highly related to fight or flight responses (Porges, 1997). This suggests that there may be autonomic differences at the level of the PNS between those who are highly anxious and those who are less anxious. If an individual is placed in a situation that elicits a stress response, and that individual is highly anxious by nature, they will respond with an exaggerated heart rate recovery. Unfortunately, an accurate representation of autonomic nervous system (ANS) control over heart functioning requires equipment that was not available. Nonetheless, the results do suggest that there may be differences between people with high and low levels of anxiety with respect to autonomic functioning.

Research has yielded varied results when testing cardiovascular and self-report measures during a stressful event. Mauss, Wilhelm, & Gross (2003) found no significant difference between high and low anxiety people on cardiovascular measures during a speech task. This could have been due to an inadequate stress induction method. Participants were required to give a speech to a camera, which may have been stressful, but may not elicit the same levels of anxiety as the favorable impressions interview, which has more ecological validity than other research protocols because it mirrors a communication dyad, albeit an awkward one.

The human body functions as a system and therefore different cognitive reactions to an event undoubtedly lead to differences in autonomic and cardiovascular reactions. Intuitively one might expect that differences in self-reported emotion measures would reflect subtle cognitive differences between high and low anxious populations. Then again self-reporting is a form of communication and participants' responses may be modulated by what they think are 'normal' levels of emotion. Interestingly, in the present study, high anxious participants reported lower levels of emotion across all emotions, except for happiness, which they reported at a higher level than low anxious people. Those who were highly anxious reported significantly less stress, surprise, and fear during the FI interview. This possibly reflects cognitive differences between high and low anxious people in that those who tend to be more anxious are more concerned about their impression management and therefore report less emotion, except happiness, because they are interested in creating a good impression for others around them. Impression management has been shown to increase people's heart rates during periods of self presentation (Sheffer, Penn, & Cassisi, 2001).

The link between cardiovascular disease and psychosocial stress leads to the question; what can we do for these people to encourage a positive health outcome? It has been shown by Merz and associates (2002) that interventions at the psychosocial level can reduce traditional risk factors for cardiovascular disease. This implies that being able to identify people with anxiety related predispositions could open up possibilities for stress reducing interventions that may result in significant reductions in cardiovascular illnesses. It is important to bear in mind that each social interaction has its own context and that individual differences between people and their ability to cope with stress ultimately can result in a large grey area making identification of these people difficult. Nonetheless, results from the present study provide a basis for further research to build upon.

Limitations of the study and future considerations

Differences in facial actions between the groups and conditions should be interpreted with some caution. Individual differences between people lead to different levels of facial expressivity, thus it was difficult to pick a specific set of facial actions that would act as behavioral markers for cardiovascular activity. The facial actions selected for this study have been associated with distress and the masking of distress, so reasonably this set of action units were the most reliable. The significant results for face data demonstrated differences between high and low anxious individuals but did not show any significant relationship between facial actions and blood pressure. One of the hypotheses of this study was that there would be a direct relationship between facial action and cardiovascular responses. There were significant results to show that specific facial movements are related to heart-rate. The correlational analyses showed that as participants' heart rate increased their frequency of smiling increased and the intensity of downward movements of the mouth increased. The relationship between facial expression and cardiovascular functioning is probably more complex than a simple bi-variate correlation, but this may be a step in relating physiology to behavior and vice-versa. Perception of any stimulus leads to cognitive assessment regarding that stimulus. It is difficult to take into consideration and control for the nearly infinite internal variables that come into the lab with each research participant. Individual differences are important to take into consideration, but are difficult to control for.

CONCLUSION

The present study addressed relationships among facial expressions, cardiovascular functioning, and self-reported emotion and compared differences in these measures between high and low anxious people. The data showed that there are differences in the facial behavior of high and low anxious participants. It also demonstrated differences in cardiovascular reactions to stress between these two groups. The results of this study provide evidence that an individual's internal experience may display external 'markers' which may allow the experiences to be identified. This could prove useful in various health care settings by aiding health care practitioners and others in detecting people at risk and implementing interventions to reduce anxiety. Overall this study provided information that may prove useful for understanding the area of anxiety, anxiety reduction as well as the reduction of anxiety related illness.

Future studies might focus on trying to associate cardiovascular responses in different settings to specific behavioral factors, such as, gesturing or other expressive behaviors.

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Appendix A: Spielberger State-Trait Anxiety Inventory – Trait Anxiety Version

SELF-EVALUATION QUESTIONNAIRE
STAI FORM X-2

NAME____ Date_________.

DIRECTIONS: A number of statements which people have used to describe themselves are given below. Read each statement and then blacken in the appropriate circle to the right of the statement to indicate how you generally fell. There are no right or wrong answers. Do not spend too much time on any one statement but give the answers that seems to describe how you generally feel.

	ALMOST NEVER	SOMETIMES	OFTEN	ALMOST ALWAYS
21. I feel pleasant	<1>	<2>	<3>	<4>
22. I tire quickly	<1>	<2>	<3>	<4>
23. I feel like crying	<1>	<2>	<3>	<4>
24. I wish I could be as happy as others seem to be	<1>	<2>	<3>	<4>
25. I am losing out on things because I can't make up my mind soon enough	<1>	<2>	<3>	<4>
26. I feel rested	<1>	<2>	<3>	<4>
27. I am "calm, cool and collected"	<1>	<2>	<3>	<4>
28. I feel that difficulties are piling up so that I cannot overcome them	<1>	<2>	<3>	<4>
29. I worry too much over something that really doesn't matter	<1>	<2>	<3>	<4>
30. I am happy	<1>	<2>	<3>	<4>
31. I am inclined to take things hard	<1>	<2>	<3>	<4>
32. I lack self-confidence	<1>	<2>	<3>	<4>
33. I feel secure	<1>	<2>	<3>	<4>
34. I try to avoid facing a crisis or difficulty	<1>	<2>	<3>	<4>
35. I feel blue	<1>	<2>	<3>	<4>
36. I am content	<1>	<2>	<3>	<4>
37. Some unimportant thought runs through my head and bothers me	<1>	<2>	<3>	<4>
38. I take disappointment so keenly that I can't put them out of my mind	<1>	<2>	<3>	<4>
39. I am a steady person	<1>	<2>	<3>	<4>
40. I get in a state of tension or turmoil as I think over my recent concerns and interactions	<1>	<2>	<3>	<4>

Appendix B: Control Interview

1. How old are you?
2. Are you left or right handed?
3. Do you exercise regularly?

   If yes, what types of exercise do you normally engage in?

   If no, what types of activities would you like to participate in?
4. How many times a week do you, or would you, partake in these activities?
5. On a normal day what would you have for breakfast?
6. On a normal day what would you have for lunch?
7. On a normal day what would you have for supper?
8. What time do you like to get up in the morning?
   a. Is it the same for the weekends?
9. What time do you like to go to bed?
   a. Is it the same for the weekends?
10. How many courses are you currently enrolled in at the University?
    a. What are they?

Note to interviewer: These questions are intended to be delivered in a casual manner and should typically be sufficient for the one minute control interview period.

Appendix C: Self-Reported Emotion Measurement Scale

Participant____________________

ER

Below are emotional scales with values ranging from 0 to 7. Please rate each type of emotion by circling the most appropriate point on the scale. As shown in the sample scale below, a score of 0 means that you did not feel any of the emotion; a score of 7 means that you experienced the emotion intensely.

0 - - - - -1 - - - - - 2 - - - - - 3 - - - - - 4 - - - - - 5 - - - - - 6 - - - - - 7

No Emotion **Extremely Intense**

Surprise	**0 - - - - -1 - - - - - 2 - - - - - 3 - - - - - 4 - - - - - 5 - - - - - 6 - - - - - 7**
Happiness	**0 - - - - -1 - - - - - 2 - - - - - 3 - - - - - 4 - - - - - 5 - - - - - 6 - - - - - 7**
Sadness	**0 - - - - -1 - - - - - 2 - - - - - 3 - - - - - 4 - - - - - 5 - - - - - 6 - - - - - 7**
Fear	**0 - - - - -1 - - - - - 2 - - - - - 3 - - - - - 4 - - - - - 5 - - - - - 6 - - - - - 7**
Disgust	**0 - - - - -1 - - - - - 2 - - - - - 3 - - - - - 4 - - - - - 5 - - - - - 6 - - - - - 7**
Anger	**0 - - - - -1 - - - - - 2 - - - - - 3 - - - - - 4 - - - - - 5 - - - - - 6 - - - - - 7**
Stress	**0 - - - - -1 - - - - - 2 - - - - - 3 - - - - - 4 - - - - - 5 - - - - - 6 - - - - - 7**

Appendix D: Information Sheet

You May Retain this Sheet for Your Information

As voluntary participants in the Psychology Subject Pool you are being asked to take part in this study.
Note: All research involving human participants at the University of Northern British Columbia (UNBC) falls under the authority of the **Human Research Committee**. All research personnel will subscribe to the ethical conduct of research and to the best of their ability protect all of the participant's interests, comfort and safety. If any issue should arise calls may be directed to the **Vice President of Research in the Office of Research at UNBC (960-5820).**
Research personnel: David Nordstokke (960-6063), Dr. Glenda Prkachin, & Research Assistants.

Purpose: The data collected from this research will be stored in a locked file cabinet. You will be asked to sign a release form for the use of your data to be used in further research. [If you wish to have your data withdrawn you should inform the principle investigator at 960-6063.] This study is intended to examine the relationship between our physiology and our behavior.

Anonymity and Confidentiality: All data collected from participants in this project will be kept confidential, and locked in a secure filing cabinet. Only research personnel listed above will have access to the files. Presentation of any data arising from this project will be presented as group summaries and no personal information will be included. As a participant in this study you will be assigned a subject number so anonymity is ensured.

Right to withdraw: There is minimal risk involved with this study; however, you may withdraw from this study without penalty at any time.

Thank you for participating in this research project.

David Nordstokke M.Sc. candidate Psychology, UNBC	Glenda C. Prkachin Associate Professor Psychology, UNBC

Appendix E: Informed Consent Sheet

Consent Form and Contact Information

Do you understand that you have been asked to be in a research study? Yes No

Have you read and taken your copy of the information sheet? Yes No

Do you understand that you are free to refuse to participate or to withdraw from the study at any time? You do not have to give a reason. Yes No

Has the issue of confidentiality been explained to you? Do you understand who will have access to the information you provide? Yes No

Do you also understand that you may ask questions and that an opportunity to discuss the research will be provided to you? Yes No

Do you agree that your data may be used in further research? Yes No

I agree to take part in this study. Yes No

Student's Name ________________________ Student's Signature________________.
[Please Print]

Researcher's Name_______________________ Researcher's Signature_____________.

Thank you for participating in this study.